POWER PLANT ENGINEERING

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TECHNICAL ADVANCE

ALTHOUGH activity in the constructional field of power plant engineering has decreased because of the general business depression, there has been considerable development in the technical end of the industry. In this issue these developments are considered on the basis of an analysis of equipment installed in some 20 stations during the year.

ACTIVITY IN THE FIELD of power plant engineering this year has proceeded along lines of technical improvement and refinement rather than in new construction as in former years. Comparatively few new power plants were constructed either in the central station or the industrial class. A number of additions to existing plants were made and in both classes a decided effort was made to improve the overall efficiency by utilizing the more modern principles of power plant practice. There is a decided tendency on the part of every engineer connected with power plant design or operation to get more kilowatts out of the same old dollar. This is as it should be. The true criterion of power plant practice is not necessarily B.t.u.'s per kilowatt-hour but kilowatt-hours per dollar. A station with a low B.t.u. per kilowatt rate may very well show a higher cost per kilowatt of output than a station having a higher heat rate.

In all departments of the power plant the trend is

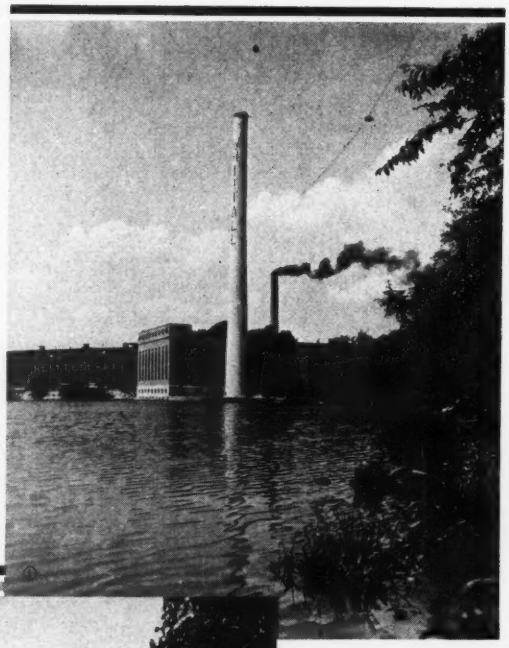

Fig. 1. New plant of M. J. Whittal Associates

Fig. 3. Moores Park Station at Lansing, Mich.

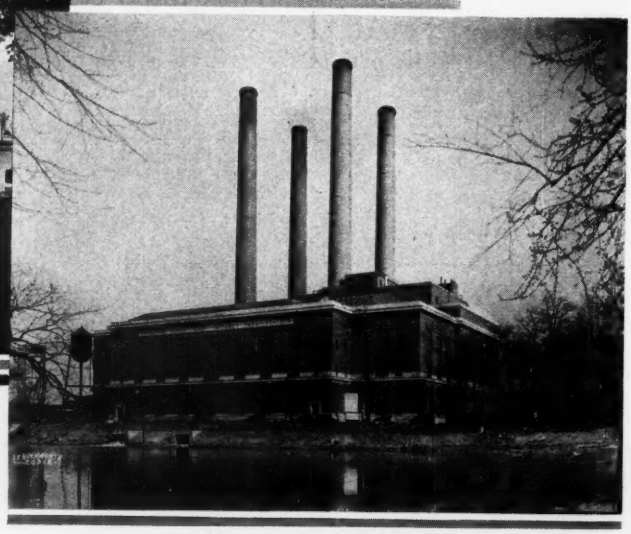

Fig. 2. Michigan City Station

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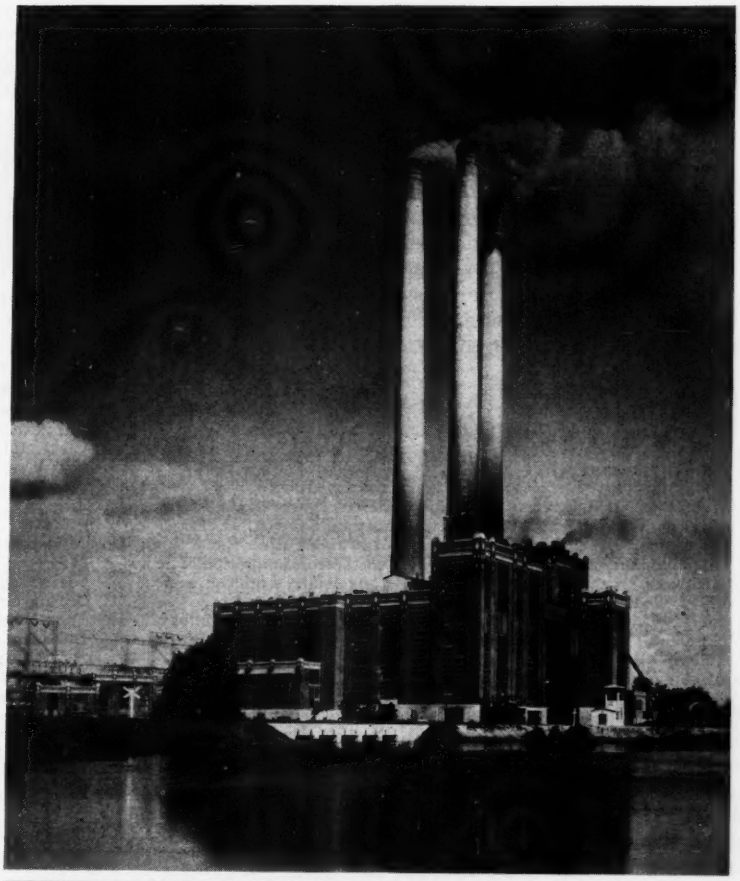


Fig. 4. Trinidad Station of the Texas Power and Light Co.

toward simplicity. This applies as well to bus layouts and switching equipment on the electrical end as it does to boiler design and heat balance on the steam end. In the boiler room particularly, the tendency toward simplification is quite apparent and in the design of Bremo Station it has gone a long way. The high single pass, inclined tube boiler which has been installed there as well as in three other stations, is extremely simple and seems to operate quite as efficiently and successfully as the old type of boiler with its innumerable accessories.

Our review of developments this year is based upon a survey and analysis of equipment installed in the stations listed in the accompanying tabulation. Not all of these plants are new, indeed approximately half of them represent additions to existing plants. The first eleven are of the central station class, either private or municipally owned; the last ten are of the industrial type serving individual industries or institutions.

In both of these two classes of plants the trend toward higher pressures and temperatures is firmly established. At least four large installations were made this year for 1400 lb., one for 1800 lb. in an industrial plant; a 2500-lb. testing boiler and a 3500-lb. experimental boiler.

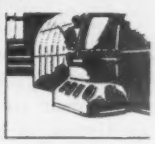
Aside from the boiler developments in the stations listed in the survey, other important developments are outdoor mercury vapor plants at Schenectady and the outdoor 1400-lb. steam central station at Herndon, Cal. These are both now under construction.

During the year, stokers have increased in size somewhat and new types of pulverizers and burners have been developed to give greater capacity and reliability. Use of water-cooled furnace walls is general with both stoker-fired and pulverized coal fired furnaces and there has been considerable development of accessories adaptable to higher pressure and higher capacity units.

Few outstanding developments have occurred during the year in coal storage and handling practice. The most unusual item is at Bremo Station where a system of loading coal from bunkers direct to pulverizer feeders was installed.

Through research, the physical and chemical properties of scale, corrosion and embrittlement are now better understood and equipment is available for using this knowledge. Embrittlement studies in the laboratory and in the field over a period of years have been concluded and the protective ratios recommended by the A.S.M.E. code have been verified.

In spite of many developments during the past few years, new turbine designs and sizes continue to be brought out and records broken. Among the notable developments are 3600-r.p.m. condensing turbines for sizes up to 15,000 kw.; a 10,000-kw. turbine for 1000 deg. F. operation; a 110,000-kw., 1200-lb. steeple compound turbine for an industrial plant and a 115,000-kw. tandem com-



pound reheat unit. Several units for the 800-850 deg. F. range are being installed or are under construction for next year and in addition two 20,000 kw. mercury turbines are now in the shops. One of these latter is to be installed at an industrial plant, the other in a central station.

Many new developments in the condenser field lead to the conclusion that there is no practical limit to the condenser shell size. At Hudson Avenue station, a 101,000 and a 100,000-sq. ft. condenser each serve a 160,000-kw. turbine. One development that will probably have considerable influence on design is the application of welding for fabricating shells. A number of such welded units have been built during the past year. Advantages claimed are lighter weight, reduced air leakage and lower costs. Auxiliary practice has been fairly well standardized, the only development of note being in air pump practice where in one station the primary stage is an ejector operated by gland leakage steam from the high pressure turbine, the secondary stage being a reciprocating dry vacuum pump.

An extension of the upper temperature limit to 1000 deg. F. together with several stations in the 800-850 deg. F. range give definite indications of considerable improvements in heat rates of the larger stations. This will increase the nonreheat pressure limit up to around 800 lb. Another important development is the start of two mercury vapor plants each with a 20,000-kw. mercury turbine. Investigations along this line for several years at South Meadow have shown that plants of this type are not only practical and reliable but extremely efficient. Open heaters have been used in a second station but the adoption of these will effect little change on the heat balance or plant layout. Radiant reheater and superheater investigations carried on at Lakeside for several years are being used in the design of the new Port Washington station to give desirable initial and reheat temperature over a load range of from one quarter to full load.

In the electrical field, the process of development during the year has been mainly one of refinement, of further perfection of details and a general better understanding of the principles involved. The design of switchgear to handle the increasing loads successfully continues to be of great importance and considerable work has been done in this direction. The deion type of breaker has performed remarkably well as has also the new oil blast type. Metal clad types of switchgear seem to be gaining in popularity and a number of installations have been made both indoor and outdoor.

Transmission voltages still have their maximum at 220,000 but there seems to be a feeling that higher voltages will be in order in the future and as Mr. Sutherland points out in an article in this issue, manufacturers are discussing among themselves as to just what they will say to the first customer who steps up to the counter and asks for a 330,000-v. equipment.

Generators are still growing in size. This year the limit has been extended to include two new units each rated at 200,000-kv-a. Voltages remain about the same, no new units built this year exceeding the 22,000-v. maximum of the State Line machines. For the time being, the question of higher generator voltages is dormant—the necessity for higher voltages apparently having been met by the development of the multiple winding machine. While no hydrogen cooled generators have been placed in commercial services, tests on a medium sized unit have been successful and it is probable that this will be the next important development in this field.

A number of large hydrogen cooled synchronous condensers have been placed in service during the year, the total capacity of hydrogen cooled condensers now in service being 137,500 kv-a. Some additional 70,000 kv-a. are on order.

In industrial service, much is being learned regarding the application of synchronous motors to industrial drives. Knowledge of the starting, acceleration and pull-in requirements has been extended and a number of unique designs were developed during the year.

Transformers are being made larger and considerable work has been done in developing methods for increasing the capacity per unit volume. New types of radiators, forced circulating of oil, improved blower systems all aid in a more effective removal of the heat generated in the windings. Considerable development also has taken place in the design of the non-resonating or so-called lightning proof type of transformer. Tests on these units indicate that they can successfully withstand lightning surges.

In the field of Diesel power, the use of the newer

LIST OF POWER STATIONS INCLUDED IN SURVEY

Name of Station	Owners	Location	Designers
Bremo	Virginia Public Service Co.	Bremo Bluff, Va.	Electric Management & Engrg. Co.
Raritan River	Jersey Central Power & Light Co.	Sayerville, N. J.	Manag't and Engrg. Corp. (Clark Int.)
Riverside Station	Northern States Power Co.	Minneapolis, Minn.	Byllesby Engrg. & Management Corp.
Ashtabula	Cleveland Elec. Illuminating Co.	Cleveland, O.	Cleveland Electric Illuminating Co.
Hudson Avenue (1931 Ext.)	Brooklyn Edison Co.	Brooklyn, N. Y.	Brooklyn Edison Co.
Tuco Station	Texas Utilities	Abernathy, Texas	Community Power & Light Co.
Trinidad (1930 Ext.)	Texas Power & Light Co.	Trinidad, Texas	Texas Power & Light Co.
Moores Park	City of Lansing, Mich.	Lansing, Mich.	J. E. Woodwell
Lakeside	Milwaukee Elec. Ry. & Light Co.	Milwaukee, Wis.	Milwaukee Elec. Railway & Light Co.
Michigan City	Northern Indiana Public Serv. Co.	Michigan City, Ind.	Sargent & Lundy, Inc.
Glenwood	Long Island Lighting Co.	Glenwood Landing, L.I.	E. L. Phillips & Co.
P. H. Glatfelter Co.	P. H. Glatfelter Co.	Spring Grove, Pa.	H. M. Wilson Co.
M. J. Whittal Associates	M. J. Whittal Associates	Worcester, Mass.	Francis J. Sill
Sunbury Converting Works	Sunbury Converting Works	Belvidere, N. J.	D. W. S. Dyer
Indiana Boys' School	State of Indiana	Plainfield, Ind.	Charles Brossman
Michigan Limestone & Chem'l Co.	Michigan Limestone & Chem. Co.	Rogers City, Mich.	Allied Engineers, Inc.
Indianapolis Hospital	City of Indianapolis	Indianapolis, Ind.	Charles R. Ammerman
Youngstown Sheet & Tube Co.	Youngstown Sheet & Tube Co.	Youngstown, O.	Youngstown Sheet & Tube Co.
Hawthorne Extension	Western Electric Co.	Hawthorne, Ill.	Western Electric Co.
Kearny Extension	Western Electric Co.	Kearny, N. J.	Western Electric Co.
World Cleaners & Dyers	World Cleaners & Dyers	Mt. Vernon, N. Y.	Breuer Engineering Co.

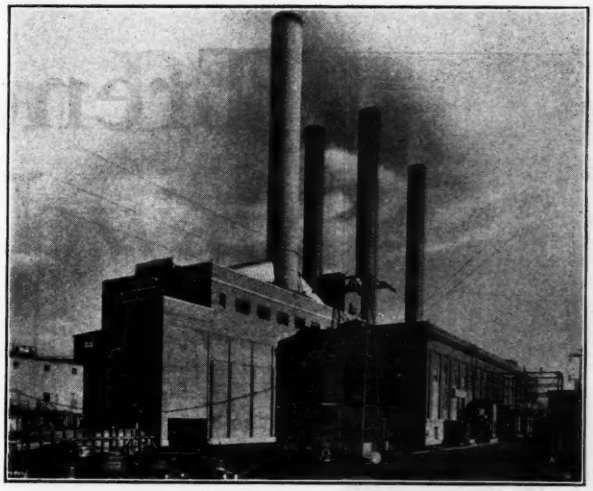


FIG. 5. RIVERSIDE STATION OF THE NORTHERN STATES POWER CO.

alloys such as chrome-nickel iron and steel has improved engine design. Further research work has been conducted on the action of oil sprays, air valves and other engine parts. Much work has been done in developing high speed, light weight Diesels for automobile and airplane work. Several large units were built during the year. In Europe an 18,000-hp. is being installed. In the United States are the five 7000-hp. double acting solid injection engines now under construction for the city of Venice, Cal. A completely automatic Diesel electric plant was placed in operation during the year at the Hotel Chelsea in New York. This contains three 75-hp. Diesels driving 50-kw. generators, connected with a storage battery and automatic control devices in such a way that the battery carries extremely low loads, also short peak loads, the engines stopping and starting and dividing the load without the supervision of an operator. Complete control is provided for failure of fuel, lubricant or cooling water. The plant operates in a basement room in total darkness.

Much interest has been shown in methods of reclaiming heat from Diesel exhaust gas. In addition to the equipment already available for this purpose, a new thimble-tube boiler for reclaiming this heat has been developed and placed on the market. Another interesting development is the use of butane engines driving gasoline pipe line pumps. The butane is sent through the gasoline line in liquid form, drawn off at the pumping station stored under pressure and released to be burned as a gas in the engines.

In hydroelectric practice, developments during the year include the placing in service of several large hydroelectric plants which were under construction last year, such as Bagnell development, Salt Springs in Calif., and others. Further construction work has been carried out on other large projects such as the Rock Island plant of the Puget Sound Power and Light Co. on the Columbia River, the Ariel plant of the Inland Power & Light Co. on the Lewis River in Washington, and the Safe Harbor project of the Safe Harbor Water Power Corp. on the Susquehanna River in Pennsylvania.

Installations of the Kaplan turbine (propeller runner with movable blades automatically adjusted by the governor) have attracted much attention. The outstanding Kaplan installation so far is at Safe Harbor where six 42,500 hp. units are being installed, built to the same design by two different manufacturers. Several other smaller Kaplan units have been installed during the year.

Several interesting installations of large outdoor and semi-outdoor hydroelectric generators have been made during the year. Among these are two 31,000-kv-a. units at Carpenter plant, two 25,000-kv-a. units at Morony plant, six 24,000-kv-a. units at Bagnell. Altogether there are 12 plants in the country with generators entirely outdoors or with an extremely small superstructure and outdoor cranes. These plants range in capacity from 250-kv-a. to 210,000-kv-a.

Large units built during the year include 92,000-hp. water wheels for the Dnieprostroy development in Russia, and two 90,700-hp. units for the Diablo projects of the city of Seattle, the latter units being the largest built up to the present time for installation in the United States. A 57,000-hp. unit at Spier Falls is the largest in physical dimensions installed in this country. For the Vargon plant in Sweden, however, some Kaplan units with runners over 26 ft. in diameter are planned, which will be the largest in physical dimensions in the world.

Research work continues on cavitation, design of dams and other items at the various laboratories of manufacturers and operating companies. Use of models for predicting performance and aiding design of hydraulic structures is finding widespread acceptance. Work is under way on the new National Hydraulic Laboratory.

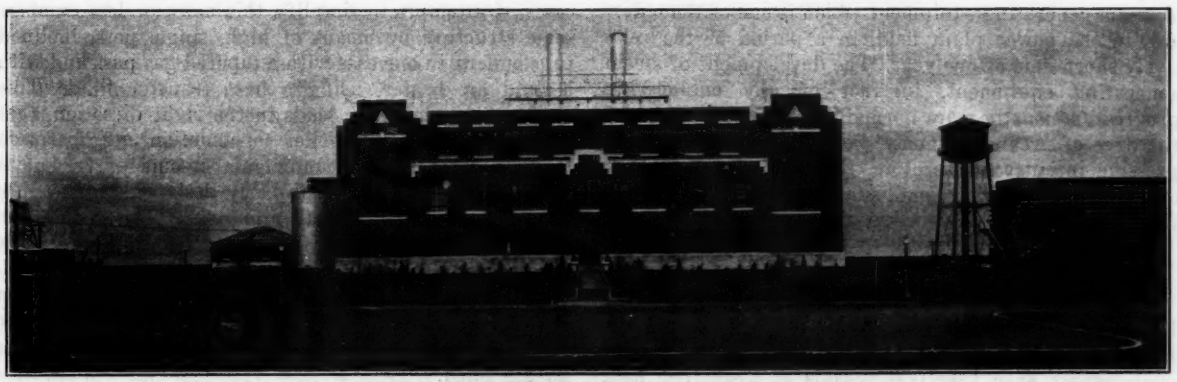


FIG. 6. TUCO STATION

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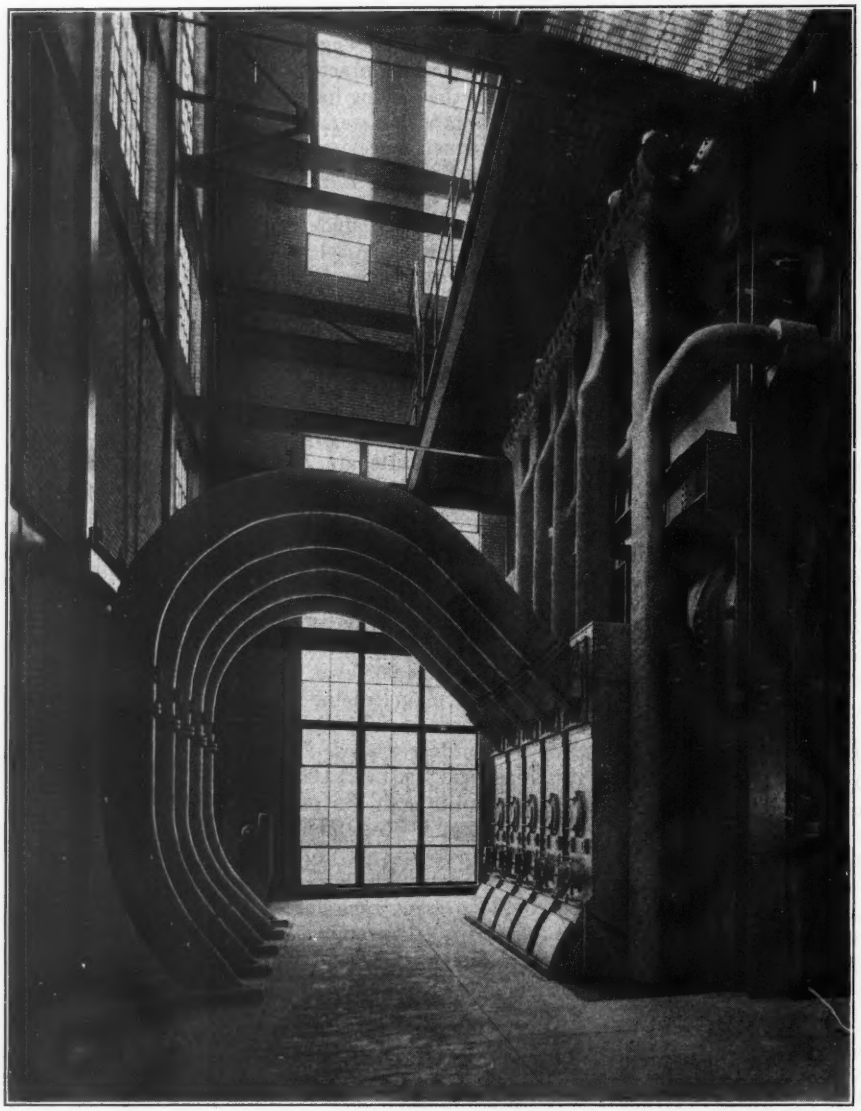


IT IS DIFFICULT TO DRAW conclusions in power plant development, particularly in the development of steam generating equipment which is one of the oldest arts in the power plant field, in a period of the relatively short time of one year. The development of steam generating equipment, in fact of any engineering progress, is usually more normally a growth fostered by the urge of greater economy, larger capacities or other pressing incentives; therefore, the development looking over the comparatively small space of time of one year is not likely to be marked or extraordinary in this aspect.

Boilers

In the past year, the tendency has continued for larger units and greater steam outputs per boiler. There have been placed in operation this year units producing considerably over 1,000,000 pounds of steam per hour which, considered in the light of the size of units a few years ago, are indeed large units. The operating boiler pressures are also continuing upward, although not at a rapid rate. Considerable experience has been gained during the year with the new high pressure stations which are in service which have demonstrated the reliability of this type of boiler unit and have pointed out the precautions necessary for proper boiler operation at higher pressures.

For a number of years, in the quest of greater efficiency, more and more auxiliaries of various kinds have been added to the boiler with the result that the boiler and its accessories were getting to be a very complicated piece of apparatus. During the year there have been several cases of attempts to simplify this more or less cumbersome structure by means of high, single pass, inclined tube boilers, in one case with a tapered gas pass and with a fluid air heater, using a heat transfer fluid. This tendency is one which leads in the right direction, that is, not only simplifies boiler construction and operation by the elimination of many cumbersome parts, but it lowers fan power and if properly designed can produce equal efficiencies to the other methods. The installation in Europe of a boiler with an extended surface on the tube sections away from the fire is an interesting development and it would not be surprising to see this carried further and these surfaces not only extended, but also the surfaces next to the fire protected and all surfaces stream lined.

At the present time, the tendency seems to favor,

in Boiler Development Toward Simplicity

Development of high single pass inclined tube boiler, units with capacities considerably over 1,000,000 lb. of steam per hour, and fluid air heaters are some of this year's contributions to boiler plant design.

By R. C. Roe

Electric Management and Engineering Corp.

for high pressures (1200 to 1400 lb.), a combination of natural circulation and series boiler construction, although there are some installations of the three drum, bent tube type, while for low pressures the tendency still seems to be divided between the inclined tube, sectional or box header type boiler and the curved tube, multi-drum type. During the past year, there have been a few installations of the high, single pass, inclined type boiler previously mentioned. These were for moderate pressures. There seems to be no good reason why this type of boiler should not be used for higher pressures and it seems to have particular advantages for high ratings per boiler section in a sectional header boiler, provided it is properly designed. In the few installations of extremely high pressures, practically all foreign, the straight series boiler of the Benson type still seems to be considerably in favor, although there is some favorable comment for the Loeffler boiler.

With certain coals, the slag problem is still being given attention and we see an increased tendency for wide spacing of the lower boiler tubes to form a slag screen and to help these conditions. In one case, a tube screen or slag screen was built part way up the furnace to improve slag conditions existing. Engineers are more and more recognizing this problem and are giving more and more thought to it in the design of their furnaces and boilers.

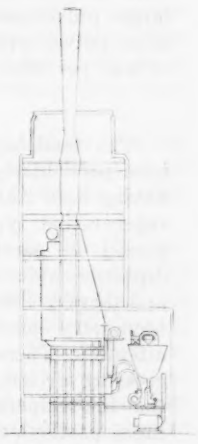
The stations installed last year with unit boilers, that is with one boiler per turbine or in some cases with two boilers per turbine as a unit, have had some operating experience and at least one other station has gone into service with this boiler arrangement installed. The operating experience appears to be favorable to this arrangement, particularly at high pressure stations and is receiving consideration by engineers for other stations.

The use of superheat control has been placed in successful operation in several stations, as well as in some few cases the use of control temperatures on the reheated steam also. This looks like a move in the right direction, even though the tendency still is toward higher and higher superheats. There seems to be a general acceptance among engineers of the practicability of going to 850 deg. or perhaps even 900 deg. in superheat and reheat temperatures when conditions are suitable for their use; in fact, many engineers are thinking along the lines of 850 deg. superheat and the omission of the reheat, particularly in cases where the pressures are not above 1000 lb.

The question of straight carbon steel tubes or various alloy tubes for high temperature superheaters has been given quite a good deal of discussion in the last year and where the temperature is low enough the consensus of opinion seems to favor straight carbon tubes, although it is recognized that for temperatures beyond the limits of this material, alloys must be used. In some of the foreign installations, some of the carbon tubes have been changed to alloy tubes during the year.

Furnaces

Furnace construction has kept pace with boiler construction and a large number, if not the majority, of the large boilers are now being equipped with water walls. In cases where these are pulverized fuel fired using slag tap furnaces, there seems to be a distinct tendency toward water cooled or air cooled furnace bottoms, the water cooled bottoms seeming to come into the greater predominance of the two. The temperature stresses on slag tap furnace bottoms is still the source of some difficulty but is being minimized by the use of water cooled or air cooled bottoms in the slag tap furnaces.



In the matter of furnaces, the tendency seems to be increasing toward the use of surfaces without refractories, particularly with higher lib-

erations. Unfortunately, high liberations have not always been accompanied by better combustion conditions and the question of furnace liberations is largely one of judgment. In general, the majority of engineers favor low or moderate furnace liberations where extreme reliability and low maintenance is a factor, and others are willing to go to higher liberation where a multiplicity of boilers exists and the opportunity for proper maintenance is therefore improved. There has been a distinct tendency toward trying to improve combustion conditions along with decreased furnace volumes by better burner design and better burner arrangement, a great deal of thought having been given by many engineers to the placing of their burners in the furnace and the effect of their location on general furnace conditions, as well as to the type of burner. This trend of thought is highly commendable and much work remains to be done to obtain the maximum results from a given furnace volume.

Water Treatment

In the matter of water treatment, the operation of high pressure plants has shown that in these plants the water conditions must be much more carefully watched than in the plants at more moderate pressures. This is true not only from a corrosion viewpoint of the boiler indicating the entire elimination of oxygen and CO_2 in the water and the extremely careful maintenance of proper PH value, but also in the silica content of the boiler feedwater to prevent carry overs which would deposit on the turbine blades. The majority of the high pressure plants have had some difficulty along these lines and have taken steps to control this situation, some going to a silica content of the boiler water of 10 parts per million or less in their endeavor to prevent this difficulty. The majority of the high pressure plants have succeeded in properly remedying this condition and it looks as if the water problem in these plants can and is being properly controlled.

Stokers and Pulverizers

In the case of stokers and pulverizers, there seems to be a continuing tendency toward the use of pulverizers, notwithstanding the fact that stoker manufacturers are constantly producing improved stokers which are capable of improved performance and which can show results approximately equal to those of pulverized fuel stations. The larger steam capacities of the large boilers have induced some of the manufacturers to construct larger pulverizers until now there are in successful operation pulverizers capable of handling fifty or more tons of coal per hour.

Air Heaters

The tendency of the year on air heaters has not been particularly marked, both plate and tubular types having been installed, with quite a few of the so-called regenerative types. During the year there has been placed in service an air heater installation using diphenyl-oxide-naphthalene as a heat transfer medium and thereby eliminating ductwork. This installation has been very successful and has attracted considerable attention. There seems to be some tendency toward increasing air temperatures, with proper care being taken that the temperature of the primary air does not get too high, particularly where primary air is used for coal drying and transportation in unit pulverizers. The space occupied by air heaters is beginning to be an important factor and is being given serious consideration by designing engineers and in some cases proposals have been made to install air heaters external to the station building.

Atmospheric Pollution

The problem of atmospheric pollution from our waste gases and stacks is one which has had unfavorable and unwarranted agitation during the year from a few of the municipal governing bodies. It is also one on which engineers have been making considerable progress, both in Europe and in this country, although the progress in Europe is more pronounced than in the United States. There have been placed in operation several installations using various methods of dust collection and dust removal from stack gases. This matter still presents a problem deserving of the engineer's attention to provide more general use of dust prevention means before the solution is forced upon the industry by unfavorable legislation and unreasonable rulings. The problem is not only one of dust removal from the gases, but is also one of dust disposal after it has been removed as has been found out during the year by some of the organizations who have taken steps for removal. This not only applies to pulverized fuel ash in the flue gas but also to cinder catchers and means for removal of dirt particles in the gas stream from the stoker fired installations. There has probably been more progress this past year on this problem, both here and abroad, than in any previous year in history but notwithstanding this progress, the problem is still an active one and needs the united attention of those responsible for power station design. This is particularly true in cases where large power plants are located in or near large centers of population.

General Tendencies

We see an increasing tendency in the past year to pay closer attention to the economics of boiler room design and in fact to the entire plant design and to produce more capacity for the dollar and examine the efficiency of each piece of apparatus to determine whether it is fully justified not only from a performance viewpoint, but also economically.

A review of the year's work would not be complete without the mention of the authorization and design of two steam mercury plants on the mercury vapor cycle which include mercury boilers, a combination of water and mercury furnace walls and many other interesting constructive developments. While these plants will not be in operation this year, the design and test work is going forward on them and we can look forward with considerable anticipation to the results that these plants will produce.

In general, the tendency in the last year has been one of steady, careful progress which the engineers and owners of power plants in this country can look back upon with pride and say that they did not stand still, that they made progress; the art has advanced but yet undue risks were not taken and major failures have not existed. With the same spirit of progress in the future, we shall see more and more development in steam generation, lowered costs of steam particularly if due care is given to the initial cost as well as the operating cost and with greater utilization of our natural resources.

Storing and Handling Fuel

WIDE VARIETY OF PLANT CONDITIONS NECESSITATES WIDE VARIETY OF EQUIPMENT AND METHODS

METHODS of storing and handling fuel in power plants preparatory to burning have not changed or developed materially during the past year. The fact that all plants shown on the accompanying tabulation possess some equipment for weighing or otherwise measuring the fuel is a clear indication that progress has been made in measuring plant performance, especially in the industrial power plant.

Perhaps the most interesting arrangement of coal-handling equipment installed during the year was that of the Bremo Station; complete details of this station were given in the May 1, 1931, issue of Power Plant Engineering. Coal delivered to the plant can be stored in a 25,000-t. storage pile by a drag scraper. Coal reclaimed by this drag scraper or unloaded direct from cars is sent to a coal breaker from which a skip hoist takes it to an automatic scale loading a belt conveyor that runs over the storage bunkers. From these bunkers the coal passes directly to the feeders of the pulverizing mills, which are set directly beneath the bunkers. The feeders consist of short belt conveyors carried on scales provided with Selsyn motors to transmit the weight indication to the control room above. At the same time, the weight of air supplied to the burners and mills is measured and the entire arrangement is designed to give a flexible accurate method of pre-measuring coal and air before they enter the burners as an aid to the boiler operator. At Bremo the coal handling equipment and pulverizing mills are all arranged in a compact assembly at one end of the boiler room, separated from it by a dividing wall. The coal feeders and weighing devices are of the same general type as those used at South Amboy last year.

VARYING CONDITIONS DEMAND VARIETY OF EQUIPMENT

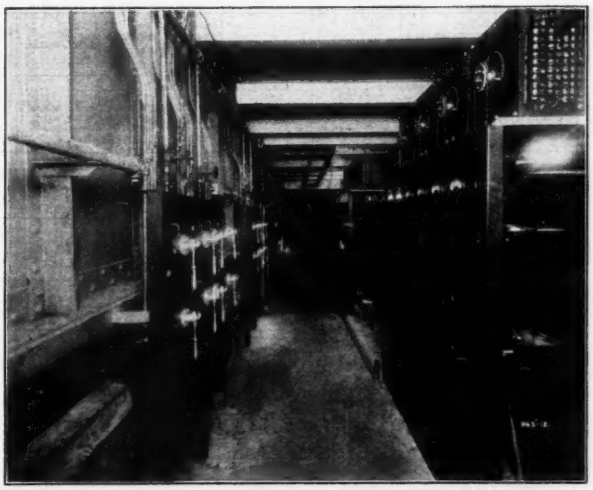
While the Bremo equipment demonstrates original and carefully thought out arrangement of standard elements, it must not be thought that the other stations on the tabulation have failed to give full consideration to this important subject. The variety of operating conditions, loads, physical characteristics of location and other similar factors influencing fuel storage are well reflected in the table.

In all cases except two, whether the fuel is coal, oil or gas, some provision is made for storage, the size of the storage pile varying from 1000 t. at the Whittall plant to 200,000 or 250,000 t. for such plants as Hudson Ave. and Ashtabula. Maximum depth of storage pile ranges from 8 ft. for the Texas lignite burned at Tuco up to 25 or 30 ft. for the Eastern bituminous coals used at Hudson Ave., the Pocahontas screenings at Riverside and the Indiana coal at Michigan City.

Unloading, storing and reclaiming equipment also shows a wide variety, dictated by a great many factors. Traveling cranes, rotary car dumpers, barge unloading towers, trestles, locomotive cranes and other types of unloading equipment are used. For storing and reclaiming, the drag scraper is used by eight of the plants tabulated; others use locomotive and bridge cranes. In most of the plants tabulated, coal is crushed or broken before it goes to the boiler house bunkers.

METHODS OF WEIGHING COAL

For conveying coal to bunkers, belt, flight and bucket conveyors, automatic trolley cars and skip hoists find their places to met the varying conditions. As pointed out above, some method of weighing coal before burning



ELECTROSTATIC PRECIPITATOR CONTROL AT GLENWOOD

is employed by each of the stations noted and this confirms the general observation that more and more care is taken in the modern power plant to measure at least the coal and water accurately. These coal weighing devices are sometimes special automatic devices as at Bremo, or automatic coal scales between bunker and coal burning equipment, as at Raritan, Moores Park, Michigan City, Michigan Limestone and Chemical and others. Some plants weigh coal in cars, as at Riverside and Ashtabula, using track scales. Hudson Ave. uses both track scales and weigh larries. Weigh larries are also used at Indianapolis Hospital, Sunbury, Glatfelter. New types of coal sampling equipment have been developed during the year to aid in checking plant performance.

Fuel for the Tuco plant is gas and fuel oil from the Amarillo field, gas brought to it by pipe line and oil by pipe or rail. Oil is stored in a 120,000-gal. underground concrete storage tank.

At the plant of Youngstown Sheet & Tube Co., the principal fuel is blast furnace gas supplemented by pulverized coal. The gas is drawn directly from the blast furnaces, a large battery of gas washers cleaning it before it goes to the boiler house. The boilers are designed to burn this gas as it is made, the amount of gas varying with the operation of the furnaces. For this reason and because there is scarcely ever a surplus

of gas, no storage is provided for it. The gas is burned up to the limit of the blast furnace output and if more steam is needed than this is able to supply, an automatic combustion control system turns on the pulverized coal, prepared in a central system. For this system, five cars of coal may be held in storage on a track under

tive landscaping, the attractively designed main building itself, provide a unified effect. Only too often the coal handling and storing equipment of a power station is little better than an eyesore and we mention the good design at Michigan City to show that such eyesores are not necessary. The cost of improving the appearance

FUEL STORAGE AND HANDLING

STATION	TYPE OF FUEL AND SOURCE	HOW RECEIVED	METHOD OF BURNING	AVERAGE OUTSIDE STORAGE TONS FUEL OIL-GAL.	MAXIMUM DEPTH OF STORAGE PILE	UNLOADING EQUIPMENT	STORAGE AND RECLAIMING EQUIPMENT	PREPARATION FOR BURNING	CONVEYORS TO BOILER HOUSE BUNKERS	BLR HOUSE BUNKERS CAPACITY TONS	HOW IS COAL WEIGHED OR MEASURED	ASH DISPOSAL
BREMO	W. VIRGINIA BITUMINOUS	RAIL	PULVERIZERS UNIT SYSTEM	25,000 T.	10 FT	TRACK HOPPER	DRAG SCRAPER	BREAKER	BELT	150 TON PER BLR.	AUTO DEVICES AHEAD OF PULV. FEEDER	SLUICE
RARITAN RIVER	PENNA BITUMINOUS	RAIL BARGE	U. F. STOKERS	70,000 T.	25 FT.	TRACK HOPPER PORTAL CRANE FROM BARGES	DRAG SCRAPER	CRUSHER	BELT	900 TONS TOTAL	AUTO. SCALES	SLUICE
RIVERSIDE	POCAHONTAS SCREENING	RAIL	U.F STOKERS	75,000 T.	30 FT.	TRACK HOPPER O'HEAD CRANE TRAVELING	LOCOMOTIVE CRANE	CRUSHERS	BUCKET ELEV. BELT CONV.	240 TONS PER BLR	IN CARS	SLUICE
ASHTABULA	PITTSBURGH NO8 BITUMINOUS	RAIL	PULVERIZED	224,000 T. AVERAGE 254,000 MAXIMUM	50 FT. R.O.M.	ROTARY DUMP'R TO TRACK HOPPER	BRIDGE CRANE	BREAKERS & PULVERIZERS	BELTS	300 T PER BLR CRUSHED 180 T PULV	TRACK SCALE AT CAR DUMPER	SLUICE
HUDSON AVE.	EASTERN BIT. R.O.M. CENTRAL & WEST. PENNA. SOUTHERN W. VA.	WATER	U.F. STOKERS	200,000 T. ENTIRE STATION	36 FT. MAX. 25 FT. AVE.	3-300 T. PER HR COAL TOWERS 3 T. GRAB HOIST MACHINE & CRUSHERS	BRIDGE CRANE	CRUSHER	5 T. AUTO TROLLEY CARS ON TRACK PASSING UNDER TOWER & OVER BUNKER	28,000 T. ENTIRE STA.	2-25 T. SCALES IN TRACK SYS. 20 TON WEIGH LARRIES & 1 AUX 20 T LARRY	SLUICE
TUCO	GAS & OIL AMARILLO FLD.	PIPE LINE & RAIL	OIL & GAS BURNERS	120,000 G. OIL UNDERGROUND CONCRETE STOR.	———	GRAVITY FEED TO UNDERGROUND TANK	GRAVITY FEED STORAGE TANK TO FUEL OIL PUMPS	———	———	———	———	———
TRINIDAD	TEXAS LIGNITE MALAKOFF TEX.	RAIL	BURNERS	17,000 T.	8 FT.	DUMPED INTO HOPPER	DRAG SCRAPER	ROLL CRUSHER & PULVERIZERS	BUCKET ELEV. & BELTS	224 T PER BLR CRUSHED 58 T. PULVERIZD	IN CARS & BY AUTO. SCALES	DRAG CONVEYOR TO CARS
MOORES PARK	WEST VIRGINIA BITUMINOUS	RAIL	U.F. STOKERS	30,000 T. TO 50,000 T.	25 TO 28 FT.	LOCOMOTIVE CRANE	STM. LOCOMOTIVE GRAB BUCKET	CRUSHER	BUCKET & BELT	1000 T.	AUTO. SCALES	CARS
LAKESIDE	EASTERN BIT. SCREENING PA. & W. VA.	RAIL WATER	PULVERIZED BIN & FEEDER SYSTEM	80,000 T. CAR 12 000 T ACTUAL FOR EMERGENCY	18 FT.	CAR DUMPER	LOCOMOTIVE CRANE	CRUSHER & HAMMR MILL., PULVERIZER ARRANGED FOR MILL DRYING WITH FLUE GASES	BELT	GREEN COAL 350 T. PER BLR PULV. 180 T.	IN CARS	SLUICE
MICHIGAN CITY	4TH VEIN INDIANA LINTON	RAIL	PULVERIZED	12,000 T.	30 FT.	GASOLINE LOCOMOTIVE CRANE	GASOLINE LOCOMOTIVE CRANE	BREAKER & PULVERIZERS	BELT	700 T/BLR.	AUTO SCALES FOR EA BLR. & BELT	SLUICE
GLENWOOD	PA. BITUMINOUS	WATER	PULVERIZED	50,000 T.	20 FT. AVE.	BARGE UNLOADING TOWER	DRAG SCRAPER	CRUSHER	SKIP HOIST	1600 T.	TRAM CAR	SLUICE
R.H. GLATFELTER CO.	PA. BITUMINOUS	RAIL	PULVERIZED	6,000 T.	10 FT.	TRACK HOPPER & ELEVATOR	DRAG SCRAPER	CRUSHER & PULVERIZER	FLIGHT	500 T.	WEIGH LARRY	PNEUMATIC
M. J. WHITTAL ASSOCIATES	NEW RIVER BITUMINOUS LILYBROOK	RAIL	U.F. STOKER	1,000 T.	35 FT.	TRACK HOPPER & BUCKET CONV.	———	———	CONTINUOUS BUCKET CONVEYOR	60 T/BLR.	INDIVIDUAL BOILER SCALES	STEAM VACUUM
SUNBURY CONVERTING WK	PA. BITUMINOUS	RAIL	PULVERIZED	1,200 T.	10 FT.	TRESTLE CAR HOPPER	DRAG SCRAPER	CRUSHER	FLIGHT & BUCKET	550 T.	WEIGH LARRIES	SLUICE
INDIANA BOYS SCHOOL	INDIANA NUT & STACK	RAIL	U.F. STOKER	———	20 FT.	BOTTOM DUMP CARS INTO STORAGE SPACE. DROPS	———	———	———	———	IN CARTS SCALES IN BOILER ROOM	MANUAL
MICHIGAN LIMESTONE & CHEMICAL CO	PITTSBURGH GAS COAL	WATER	U.F. STOKERS	5,000 T.	30 FT.	BOATS	CRANE	———	BELT	125 T. PER BLR	BELT TO AUTO SCALES	HOPPERS
INDIANAPOLIS HOSPITAL	INDIANA BITUMINOUS.	TRUCKS	C.G. STOKERS	4,000 T.	10FT.	TRACK HOPPER	DRAG SCRAPER	CRUSHER	BUCKET ELEV.	WEIGH LARRY	250 T.	ASH BUGGY & SKIP HOIST
YOUNGSTOWN SHEET & TUBE CO.	B. FURNACE GAS	PIPE FROM B.F.	GAS BURNERS	———	——	———	———	GAS WASHERS	PIPING	——	——	———
	COAL AUX.	RAIL	PULVERIZED	———	——	SKIP HOIST & LOADER	SKIP HOIST & LOADER	CRUSHER	SKIP HOIST TO BUNKER	——	——	SLUICE
HAWTHORNE WESTERN ELECTRIC	INDIANA & ILLINOIS BITUMINOUS	RAIL	C.G. STOKERS	12,000 T.	15 FT.	LOCOMOTIVE CRANE	———	CRUSHER	BUCKET CONV	1500 T.	IN CARS AUTO SCALE FOR TEST	BUCKET CONV.
KEARNY WEST ELECT.	PA. BALEY	RAIL	C.G. STOKERS	12,000 L.T.	24 FT.	CARRIER	DRAG SCRAPER	SUMMER-NONE WINTER CRUSHER	CARRIER	600 T.	IN CARS METR. AT BLR.	CARRIER
WORLD CLEANERS-DYERS	FUEL OIL	RAIL	BURNER	10 000 G.	——	PUMPS	——	ELEC. HTRS. & STRAINERS	PUMPS	——	——	——

the boiler house, whence it can be loaded to the green coal bunker by a skip hoist.

Particular attention is directed to the artistic design of the coal handling system buildings at Michigan City, as shown on page 1170 of this issue. The coal handling equipment appears in this photograph to be an integral part of the station, as if it were designed with it and not tacked on haphazard. The arches on the conveyor supports, the design of the breaker house and the attrac-

of this equipment in the original design would be extremely small, in most cases.

Following the trend toward simplification by using single boiler and turbine units and improved designs, larger coal pulverizing units have been built to reduce building space and to lower operating costs. Outstanding among such large mills is that at Kips Bay for 50 t. an hr., driven by a 500-hp. direct-connected synchronus motor.

Steam Making Equipment Shows Steady Progress

VERTICAL SINGLE-PASS BOILER, UNIT ASSEMBLIES, OUTDOOR STEAM STATIONS, MERCURY VAPOR PLANTS, STEAM PRESSURES IN USE UP TO 1800 LB., EXPERIMENTS WITH PRESSURES UP TO 3500 LB., TEMPERATURES USED UP TO 1000 DEG., DIPHENYLOXIDE AIR PREHEATER, HIGH CAPACITY STOKERS AND PULVERIZED COAL EQUIPMENT, CENTRALIZED CONTROL, WELDING PROGRESS ARE AMONG OUTSTANDING DEVELOPMENTS IN 1931

CONSIDERING the boiler room as a whole, there has been considerable development in 1931 of equipment and methods leading toward further simplification and higher economy in boiler operation. As Mr. Roe has pointed out in the preceding article, the boiler itself was on the way to becoming a rather complicated piece of apparatus. An attempt has been made to simplify it by developing the high single-pass, inclined-tube boiler, which has been installed in four stations. In one of these, a fluid air heater was used, employing diphenyl-oxide as the heat exchange medium. The unit assembly idea—that is, one boiler and one turbine operating together—has also aided in simplifying stations. This unit arrangement, together with the vertical compound turbine, the omission of dividing walls between turbine and boiler rooms and other devices have been helpful in reducing costs of buildings and in simplifying operating procedure. Many engineers believe that there is an unmistakable trend toward the unit assembly.

By this time the trend toward higher pressures and temperatures both in central stations and industrial plants, is firmly established, as evidenced by at least four large installations this year for 1400 lb., one for 1800 lb. in an industrial plant, a 2500-lb. testing boiler, a 3200-lb. experimental boiler and several industrial plants designed for 300 to 400 lb. The general interest in increasing steam temperatures continues, one unit having already operated at 1000 deg. and others having been planned for raising the temperature to about 825 deg. later on.

TWO OUTDOOR PLANTS AND TWO MERCURY-VAPOR PLANTS

Two outstanding items are the outdoor mercury vapor plant at Schenectady and the outdoor 1400-lb. steam central station at Herndon, Cal., both now under construction. In the face of the generally-expressed opinion of many engineers that the outdoor station is impractical, these two plants are being built for use in two entirely different climates.

Two mercury-vapor plants are under construction: the Schenectady plant referred to above, a 20,000-kw. unit, and a similar 20,000-kw. mercury-vapor plant at Kearny Station in New Jersey. Complete details of the Schenectady mercury-vapor plant were given in the Feb. 15, 1931, issue of Power Plant Engineering and Fig. 2 shows a model of the plant as it is expected to appear when completed. The design of the unit is based on generating 20,000 kw. from the mercury turbine and 330,000 lb. of steam an hour, of which 240,000 lb. an hour will be from the mercury condenser and 90,000 lb. from the furnace water walls. Besides this, a steam boiler will supply an additional 300,000 lb. an hour. The Kearny installation will consist of a 20,000-kw. mercury-vapor turbine-generator and boiler, also a 75,000-kw. steam turbine-generator and addition of water walls on 11 boilers. Both these installations will include mercury heating surface in the upper parts of the furnace walls.

Considerable work is being done in simplification of station piping, to avoid duplication of lines that are seldom used and to reduce the number of valves and fittings. Study has also been made to avoid duplication of auxiliaries where possible with safety. The multi-stage condensate and heater pumps used at South Amboy and Bremo are examples of this, although their primary purpose is to secure better control of condensate flow. Welding is finding wide application in piping and other power plant work.

FANS

STATION	FORCED DRAFT TYPE	FORCED DRAFT NO. PER BLR.	FORCED DRAFT CAP. EACH C.F.M.	FORCED DRAFT CAP. TOTAL C.F.M.	FORCED DRAFT DRIVE	FORCED DRAFT STATIC PRESS IN. H_2O	INDUCED DRAFT TYPE	INDUCED DRAFT NO. PER BLR.	INDUCED DRAFT CAP. EACH C.F.M.	INDUCED DRAFT CAP. TOTAL C.F.M.	INDUCED DRAFT DRIVE	INDUCED DRAFT STATIC PRESS INCHES H_2O	CHIMNEYS NO. BLRS PER CHIMNEY
BREMO	PRIM.-STEEL PLATE SEC.—TURBO CONOIDAL	3 3	5840 19,480	97,180	VAR. SPEED A.C. MOTOR	11-2 5-5	INTEGRAL WITH VENTURI 28IN.	2	42,300	84,600	VAR. SPEED A.C. MOTOR	5-5	1
RARITAN RIVER	STEEL PLATE	1	53,000	——	DUAL A.C. MOTOR	8-3	SUPER DUPLEX		107,000	——	DUAL A.C. MOTOR	7.2	
RIVERSIDE	SUPER TURBO	1	97,000	——	VAR. SPEED A.C. MOTOR	6-7	SUPER DUPLEX	2	95,780	——	2 SPEED A.C. MOTOR	8.72	3
ASHTABULA	MULTI-VANE	2	10,000	20,000	A.C. INDUCTION MOTOR	20	TURBO VANE	1	327,000	——	A.C. 2 SPEED MOTOR	15-0	2
HUDSON AVE.	TURBO VANE	TRANS. 8 BLRS.	200,000	1,600,000	A.C. MOTOR	10	TURBO VANE	2	155,000	310,000	A.C. MOTOR	20	8
TUCO	STEEL PLATE	1	22,150	——	A.C. BRUSH SHIFT. MOTOR	2-5	STEEL PLATE	1	37,000	——	A.C. 4 SPEED MOTOR	1-8	1
TRINIDAD							NATURAL DRAFT						
MOORES PARK	STEEL PLATE	1	82,500 98,500	—— ——	D.C. MOTORS	10	MULTI BACK	1	133,000 158,000	—— ——	D.C. MOTORS	10	2
LAKESIDE	STEEL PLATE	2	42,000 AT 3.5 IN. 47,000 AT 10IN.	84,000 94,000	A.C. MOTOR	3.5 TO 10	STEEL PLATE	2	92,000	184,000	A.C. MOTOR	11-8	2
MICHIGAN CITY	TURBO VANE	1	98,200	——	A.C. INDUCTION MOTOR	8-8	TURBO VANE	1	177,000	——	AC. INDUCTION MOTOR	13-0	3
GLENWOOD	MULTI VANE	1	125,000	——	DUAL A.C. MOTOR	12	MULTI VANE	1	209,000	——	DUAL A.C. MOTOR	12.5	
PHILADELPHIA GAS & ELECTRIC CO	TURBO VANE	1	53,000	——	A.C. MOTOR	8-0	MULTI VANE	1	96,000	——	VAR. SPEED A.C. MOTOR	5"	3
W.J. WHITTALL ASSOCIATES	TURBO CONOIDAL	1	19,000	——	TURBINE	5-5	NONE						
SUNBURY CONVERTING WORKS	TURBO VANE	1	——	——	SLIP RING MOTOR		MULTI VANE	1			SLIP-RING MOTOR		1
INDIANA BOYS SCHOOL	SEE AIR PREHTR.	1 FOR 2	18,300	——	TURBINE	——	SEE AIR PREHTR.	—	204,000	——	TURBINE	——	2
MICHIGAN LIMESTONE & CHEMICAL CO.	STEEL PLATE	1	34,500	——	AC. 2 SPEED MOTOR	7-0	STEEL PLATE	1	69,500	——	AC. 2 SPEED MOTOR	5-0	1
INDIANAPOLIS HOSPITAL	STEEL PLATE	1	23,000	69,000	ENGINE	2-5	NONE						
YOUNGSTOWN SHEET & TUBE CO.	STEEL PLATE	1	198,000	——	A.C. 2 SPEED MOTOR	13-0	RADIAL BLADE	1	184,000	——	SLIP RING MOTOR	8-4	
HAWTHORNE WESTERN ELEC.	4—CURVED BLADES 6—AEROPLANE PROP.	1 1	30,000 30,000	—— ——	2 SP. IND. MOT. IND. MOTOR	2-5	CURVED BLADES	1	48,000	——	STEAM ENGINE	8.25	8
KEARNY WESTERN ELEC.	TURBO VANE	1	43,000	——	CONST. SPEED MOTOR	5-0	TURBO VANE	1	78,000	——	TURBINE	5-25	4
WORLD CLEANERS & DYERS							NATURAL DRAFT						

Centralized control of entire power plants has also received considerable attention, Bremo being the outstanding example. Centralized control of boilers alone is common practice, as illustrated by most of the plants considered in this analysis.

Stokers have increased in size somewhat, new types of pulverizers and burners have been developed to give greater capacity and reliability, use of water cooled furnace walls is general with both stoker-fired and pulverized coal-fired furnaces and there has been considerable development of accessories such as water gages, draft gages, combustion control equipment and the like, all adaptable to higher pressures and high capacity units.

The foregoing, in general, constitute the outstanding items in the year's development. Let us now consider some of them in detail.

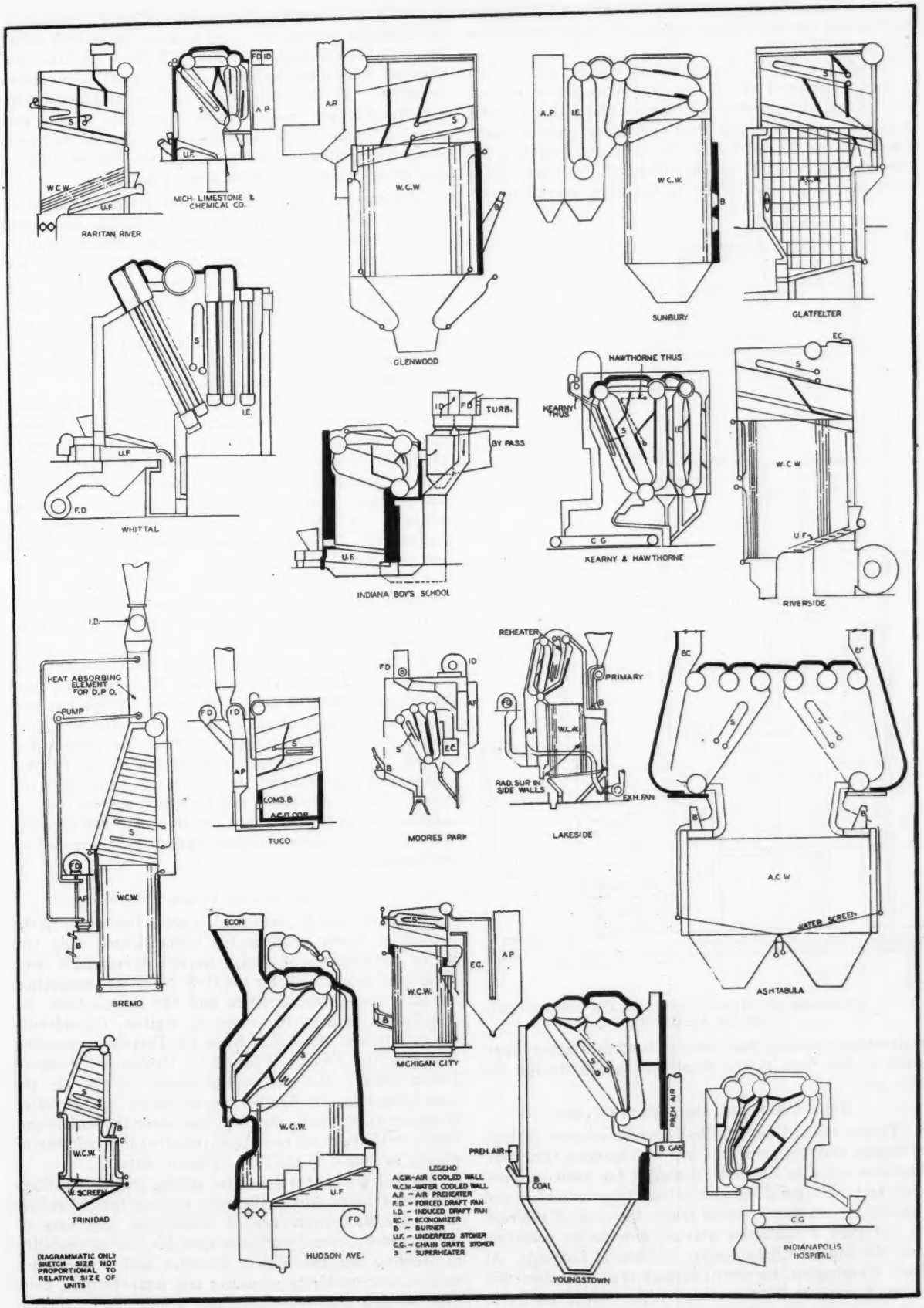
As an example of the unit assembly idea of one boiler serving one turbine-generator, Bremo Station contains two 15,000-kw., 3600-r.p.m. steam turbine generator units, each supplied with steam by a single-pass vertical, inclined-tube boiler. Space is left in the station for a third boiler but at present the station operates satisfactorily without reserve capacity. This unit idea is also to be used at Port Washington, now under construction, where an 80,000-kw. turbine will be supplied with steam by a single boiler unit. Modifications of this idea are Tuco Station, with one 7500-kw. unit served by two boilers and Michigan Limestone and Chemical Co., designed for an ultimate installation of two turbine-generators and three boilers. Ability of boilers to stay on the line as long as the turbine they serve has permitted these arrangements that help in reducing investment and operating costs.

Vertical Single-Pass Boilers

The vertical single-pass boiler is an indication of the trend toward simplification of boilers and reduction of costs. At Bremo, two units 39 tubes high, with tapering gas passages, were installed, each having a maximum capacity of 200,000 lb. an hour. The Trinidad units of the same type are 43 tubes high and each is designed to produce 325,000 lb. of steam an hour. At the Boncar plant of West Virginia Hydroelectric Co. and at the Duluth Station of Minnesota Power & Light Co. vertical single-pass boilers 40 tubes high are installed but these boilers do not taper towards the top like the first two mentioned. They were described in detail and their advantages discussed in the Aug. 15, 1931, issue of Power Plant Engineering.

All four of these boilers are fired with pulverized coal, have water-cooled furnaces and are designed for moderate pressures, 415 to 540 lb. The convection superheaters are between the first and second tube decks and produce steam temperatures of about 750 deg. The

	FURNACES											
									WATERWALL SURFACE			
STATION	FUEL & METHOD OF FIRING	HEATING SURFACE SQ. FT. EACH	FURNACE VOLUME CU. FT. EACH	RATIO FURNACE VOLUME TO HTG. SURF.	MAXIMUM B.T.U. LIBERATED PER CU. FT. PER HR.	CORRESPONDING OUTPUT IN LB. STM. PER HR.	ARE ECONOM'Z'S USED ?	ARE A. PRE HTR USED ?	SQ. FT. PER BOILER	PERCENT OF TOTAL HTG. SURFACE	TYPE	FURNACE BOTTOM TYPE
BREMO	W. VA. BITUMINOUS PULVERIZED	21,674	9,400	0·433	26,200	200,000	NO	YES	1838	8.5	PLAIN TUBES WING BACK BLKS	SLAG TAP
RARITAN RIVER	PA. BITUMINOUS STOKERS	12,416	6,500	0·55	39,400	190,000	YES	YES	606.5	3·7	C.I. BLOCKS PLAIN TUBES SIDES & REAR ABOVE STOKERS	———
RIVERSIDE	POCAHONTAS SCREENINGS U.F. STOKERS	21,090	10,600	0·503	34,000	250,000	YES	NO	1066	3.11	PLAIN TUBES C.I. BLOCKS FUSED ON	———
ASHTABULA	PITTS. NO. 8 PULVERIZED	33540 INCLUD. 980 SQ. FT. WATER SCREEN	32560 ABOVE WATER SCREEN	0.971	18 500	416 000	YES	NO	980 WATER SCREEN	2.9	PLAIN TUBES	DRY-AIR COOLED HOPPER & WATER SCREEN
HUDSON AVE.	EASTERN BIT. R.O.M. U.F. STOKERS	24,450	14,000	0.57	54,770	530,000	YES	NO	3,846	6.8	FIN TUBES C.I. BLOCKS	———
TUCO	NATURAL GAS FUEL OIL AUXILIARIES	7,673	2,750	0.349	28,000	62,400	NO	YES	——	——	——	AIR COOLED
TRINIDAD	TEXAS LIGNITE PULVERIZED	37,532	19,500	0·52	25,000	325,000	NO	NO	5,845 INCLUDING HEARTH SCREEN	12.5	FIN TUBE	REFRACTORY AIR COOLED
MOORES PARK	W. VA. BITUMINOUS STOKERS	2-18.762 2-19,606	8,962 10,369	0.53	28,000	224,000 252,000	YES	YES	2-812 2-846	4.8 4.3	C.I. BLOCKS SHRUNK ON	———
LAKESIDE	EASTERN BITUM. BIN & FEEDER	28,845 BOILER & W.W. & SCREEN	28,573 ABOVE WATER SCREEN	0.99	14,100	300,000	NO	YES	5,205	18.0	W.S. BARE TUBES	HOPPER BOTTOM
MICHIGAN CITY	4 VEIN IND. LINTON PULVERIZED	24,376	14,700	0.602	29,350	350,000	YES	YES	2,250	9.23	C.I. BLOCKS	SLAG TAP
GLENWOOD	PA. BITUMINOUS PULVERIZED	22,636	11,700	0.583	43,720	300,000	NO	YES	2,800	9.4	PLAIN TUBES & C.I. BLOCKS	HOPPER BOTTOM
GLATFELTER PAPER CO.	PA. BITUMINOUS PULVERIZED	11,380	6,500	0.571	20,000	116,000	YES	NO	290	2.5	PLAIN TUBES C.I. WINGBACK BL.	AIR COOLED REF. SIDE WALL 5,125 SQ FT BOTTOM 60 SQ FT
M.J. WHITTAL ASSOCIATES	LILYBROOK U.F. STOKERS	5,135 BLR. & WATER WALL	1,500	0.292	21,500	30,000 NORMAL	YES INTEGRAL	NO	72 REAR WALL ONLY	1.4	PLAIN TUBES & C.I. BLOCKS	—— ——
SUNBURY CONVERTING WORKS	PA. BITUMINOUS PULVERIZED	13,550	8,600	0.635	18,900	125,000	YES	YES	5300	64.1	PLAIN TUBES WITH REFRACTORY BACKING	WATER COOLED
INDIANA BOY'S SCHOOL	IND. BITUMINOUS U.F. STOKERS	1800-45 SQ. FT. GRATE SURF.	398	0.221	11,500	212,000 PER 24 HOUR MAX.	NO	YES	——	——	——	STOKER GRATE
MICH. LIMESTONE & CHEMICAL CO.	PITTS. GAS COAL STOKERS	8,797	3,000	0.341	32,000	80,000	NO	YES	145	1.62	PLAIN TUBES C.I. BLOCKS	———
INDIANAPOLIS CITY HOSPITAL	COAL C.G. STOKERS	5,128	1,387	0·27	——	——	NO	NO	NOT USED	—	——	———
YOUNGSTOWN SHEET & TUBE CO.	BLAST FURNACE GAS AND PULV. COAL	20,283	20,500	1·00	12,562	180,000	NO	YES	AIR COOLED SETTING DESIGNED SO THAT W. WALLS CAN BE ADDED LATER			AIR COOLED
HAWTHORNE WESTERN ELECTRIC	INDIANA & ILLINOIS BITUMINOUS STOKERS	7,778	1,900	0.244	45,000	60,000	YES	NO	565	5.1	PLAIN TUBES AND SPL. BRICK	———
KEARNY WESTERN ELECTRIC	PA. BALEY G.G. STOKERS	8,400	1,720	0.205	79,200	87,500	YES	NO	—	—	——	———
WORLD CLEANERS & DYERS	FUEL OIL	2550	——	——	——	——	NO	NO	NONE	——	——	———


RARITAN RIVER
MICH. LIMESTONE & CHEMICAL CO.
GLENWOOD
SUNBURY
GLATFELTER
WHITTAL
INDIANA BOY'S SCHOOL
KEARNY & HAWTHORNE
RIVERSIDE
BREMO
TUCO
MOORES PARK
LAKESIDE
ASHTABULA
TRINIDAD
HUDSON AVE.
MICHIGAN CITY
YOUNGSTOWN
INDIANAPOLIS HOSPITAL
HAWTHORNE THUS
KEARNY THUS
BY PASS
REHEATER
PRIMARY
RAD. SUP IN SIDE WALLS
EXH. FAN
HEAT ABSORBING ELEMENT FOR D.P.O.
PUMP
ECON
PREH. AIR
B. GAS
B. COAL
WATER SCREEN
LEGEND
A.C.W.=AIR COOLED WALL
W.C.W.=WATER COOLED WALL
A.P. = AIR PREHEATER
F.D. = FORCED DRAFT FAN
I.D. = INDUCED DRAFT FAN
EC. = ECONOMIZER
B. = BURNER
U.F. = UNDERFEED STOKER
C.G. = CHAIN GRATE STOKER
S = SUPERHEATER
DIAGRAMMATIC ONLY SKETCH SIZE NOT PROPORTIONAL TO RELATIVE SIZE OF UNITS

Bremo boilers are equipped with diphenyloxide air preheaters but the other three types have no air preheaters or economizers.

Draft loss of these boilers is low; Boncar and Duluth units are equipped with forced draft fans but no induced draft fans; Bremo uses both forced and induced draft fans, while the Trinidad units operate on natural draft. The low draft loss of these units, their simplicity of construction resulting in a minimum of auxiliary equipment and their possibilities in reducing operation and

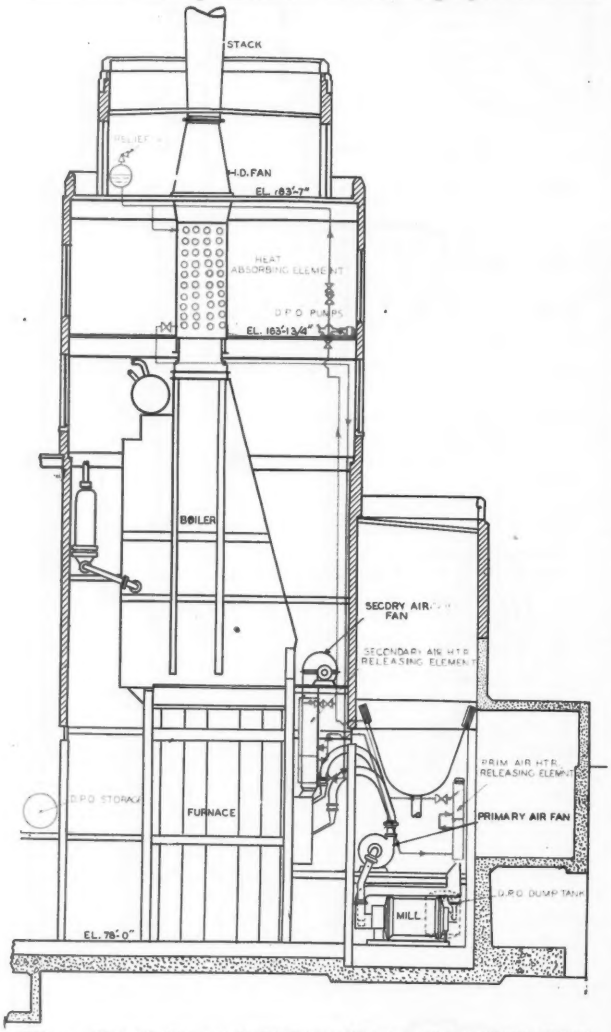


FIG. 1. DIAGRAM OF DIPHENYLOXIDE AIR PREHEATING SYSTEM AT BREMO

maintenance charges have been indicated in actual operation in the four plants mentioned above during the past year.

High Pressures and Temperatures

Trends toward more widespread acceptance of high pressures and temperatures are well-marked this year. The new units at Lakeside, designed for 1400 lb. pressure and incorporating convection type reheater and radiant superheater, possess many features of interest. At the Port Washington Station, now under construction, the boilers will be similar to those at Lakeside. At Port Washington, however, radiant type reheaters will be used, with radiant and convection superheaters in series.

At Bremo, desuperheaters controlled by automatic thermostatic devices are used to keep the initial steam temperature constant. At the Ford Motor Co. the new vertical compound turbines are equipped with steam reheaters. At Riverside, both radiant and convection superheaters are used. Proper operation of gas and steam reheaters, either separately or in series, has been given much attention and some valuable information on operating practice has been made available.

Among the other high-pressure plants installed or under construction during the year should be mentioned the Herndon plant in California, an outdoor station, designed for 1400 lb. pressure. New 1400-lb. turbine and boiler units are under construction at State Line. The Delray 1000-deg. turbine has been operated for a short period with steam at 1000 deg. F. total temperature and the experimental superheater at almost 1200 deg. F.

Bremo Station is designed for a possible total steam temperature of 825 deg. in the future.

Experimental work with a boiler operating at about 3500 lb. pressure has been carried on at Purdue University. A manufacturer of valves and boiler accessories has installed a testing boiler operating at 2500 lb. pressure as described in the Dec. 1 issue of Power Plant Engineering. For an industrial company a boiler plant designed for 1800 lb. working pressure has been installed. The 700,000-lb.-an-hour boilers for the 1200-lb. vertical compound 110,000-kw. turbine-generators at Ford Motor Co. are the largest 1400-lb. boilers to be installed during the year but other existing boilers have been operated to produce well over 1,000,000 lb. of steam per hour per boiler.

Interest in the slag tap furnace continues and two outstanding stations of the year, Michigan City and Bremo, are equipped with them. Some trouble has been reported with such furnaces at several plants that installed them in the last year or two; the trouble was caused mostly by horizontal expansion of the furnace bottom and some difficulty in finding the proper material for it. These difficulties are now well on the way to solution and engineers do not feel that they will preclude the use of the slag tap furnace where it is warranted by the conditions.

Welding in the Power Plant

While the power plant field is much interested in the subject of fusion welding for boiler drums, only two major installations of fusion welded drums have been made: the drums built for the U. S. Navy for installation on three new scout cruisers and the drums built for installation in a southern central station. Considering the activities of the A.S.M.E. on the Proposed Specifications for the Fusion Welding of Drums or Shells of Power Boilers, the way will probably be open in the near future for the further use of fusion welded boiler drums in cases where they will best meet the conditions. Forge welded drums have been installed in a number of plants, as shown on the table of boiler data.

Increased use of welding for piping and pipe fittings has been evident during the year, tending toward reduction of cost, convenience of installation and ease of maintenance. Some engineers question the advisability of welding for the higher pressure and temperature ranges. For moderate pressures and temperatures, however, welded pipe work has been widely used. Several companies have placed on the market fittings especially

COMBUSTION EQUIPMENT

STATION	HEATING SURFACE SQ. FT EACH	BLR. DRUM PRESSURE LB. PER SQ.IN. ABSOLUTE	FURNACE VOLUME CU.FT. EACH	FUEL KIND AND B.T.U.	% MOISTURE INITIAL	PULVERIZING MILLS: TYPE	NO PER BLR.	CAP TON PER HR. EA	DRIVE AND POWER CONSUMED KW. HR/TON	MAXIMUM & MINIMUM FINENESS % THROUGH 200 MESH	BURNERS: TYPE	NO. PER BLR	AIR SUPPLY: PRIMARY % TOTAL	PRIMARY WHERE INTRODUCED	PRIMARY TEMP. DEG. F.	SECONDARY % TOTAL	SECONDARY WHERE INTRODUCED	SECONDARY TEMP. DEG. F.	STOKERS: TYPE	LB. COAL PER SQ.FT. PER HR. MAX.	RATIO OF BLR. HTG. SURFACE TO SQ.FT GRATE	PROJECTED GRATE AREA SQ. FT	DRIVE	NUMBER RETORTS UNDER FEED	NUMBER TUYERES UNDER FEED	CHAIN GRATE LENGTH-L WIDTH-W IN FEET	STOKER AIR SUPPLY: ZONE CONTROL IF SO-NO. ZONES	AIR FOR COMBUSTION: PRESSURE INCHES H2O	TEMP °F.	CORRESPONDING OUT PUT PER BLR
BREMO	21,674	340	9,400	W.VA BITUM. 13,600	4.0	AIR SWEPT BALL	3	3-3.5	INDUCTION MOTOR 13-4	90	HORIZONTAL TURBULENT	3	3	MILL EXIT & ENTRANCE	340	70	BURNERS	427	NONE	—	—	—	—	—	—	—	—	—	—	—
RARITAN RIVER	12,816	485	6,500	PA. BITUMINOUS 13,800	1.0	—	—	—	—	—	—	—	—	—	—	—	—	—	U.F.	53.2	33.9	348.6	A.C. MOTOR GEAR REDUCTION	10	—	—	—	8.3	350	190,000
RIVERSIDE	21,090	465	10,600	POC. SCREENING 13,500	4	—	—	—	—	—	—	—	—	—	—	—	—	—	U.F.	68 MAX-4 HR. 56-24 HR.	43.3	487.22	HYD. VAR. SPEED	14	45 WITH OVERFEED SECTION	—	2	8-7 MAX. 4 HR. 36 24 HR.	70	300,000 MAX. 4 HR. 250000-24
ASHTABULA	32,560	410	32,560 ABOVE W. SCREEN	PITTS NO.8 BIT 12,650	3-5	ROLLER	1	15.	INDUCT. MOTOR 15 KW HR/T	73 - MAX. 65 MIN.	VERTICAL FAN TAIL	16	12	BURNERS	100	88	FURNACE BE LOW BRNRS.	140	—	—	—	—	—	—	—	—	—	—	—	—
HUDSON AVE	56,536 COMBINED SURFACE	780	141,000	EASTERN BITUM. 14,000	4-5	—	—	—	—	—	—	—	—	—	—	—	—	—	U.F.	82		694	HYDRAULIC	15	85	—	—	7.5	70	510,000
TUCO	7,674	290	2,750	NATURAL GAS 950 PER CU.FT	—	—	—	—	—	—	COMBINATION GAS & OIL	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
TRINDAD	37,332 WITH WW & HEARTH S.	465	19,500	TEX. LIGNITE 7,000	31	BALL	1	25.1	MOTOR 14	98.5	EDFAN TAIL DOWN SHOT	14	12.5	BURNERS	150	75 SEC. 12.5 TER.	FRONT WALL	ROOM	—	—	—	—	—	—	—	—	—	—	—	—
MOORES PARK	2- 18,762 2- 19,608	365	8,986 10,369	W. VA 14,136 DRY	2.52	—	—	—	—	—	—	—	—	—	—	—	—	—	U.F.	55	43.52 44.52	382 440.6	MOTORS & GEAR BOXES	2-13 15	41	—	—	10	350	228,000 298,000
LAKESIDE	28,845	1,405	28,573	EAST SCREEN 12,800	5.0	ROLLER	1	20	MOTOR 15.6	66	VERTICAL	12		BURNER	620	—	FRONT WALL	620	—	—	—	—	—	—	—	—	—	—	—	—
MICHIGAN CITY	24,376	665	14,700	4 VEIN IND.LNT. COAL	11.0	BALL TABLE	2	12.5	INDUCT. MOTOR 10-16	65—80	CROSS TUBE & VORTEX	4	20	MILL BOTTOM & END	400 TO 500	80	BURNER	400 TO 500	—	—	—	—	—	—	—	—	—	—	—	—
GLENWOOD	22,836	465	11,700	PA. BITUMINOUS 14,600	3-5	AIR SER TABLE	—	2-13 1-34	MOTOR —	70	INTERTUBE TURBULENT	4	26	AT BURNER	180	74	BURNER	573	—	—	—	—	—	—	—	—	—	—	—	—
PHGLATFELTER CO	11,380	365	8,500	PA.BITUMINOUS 14,000	1.5	IMPACT	2	7,500	100 HP. MOTOR 20	88 MAX.	TURBULENT	2	10	PULVERIZER	208	90	BURNER	140	—	—	—	—	—	—	—	—	—	—	—	—
M.J.WHITTAL ASSOCIATES	8,135	215	1,800	LIL YBROOK 14,658 DRY	0.66	—	—	—	—	—	—	—	—	—	—	—	—	—	U.F.	47	40.1	103	TURBINE	5	3.2 PER ROW	—	—	5.3	70	60,000
SUNBURY CONVERTING WKS.	13,950	375	8,600	PA. BITUMINOUS 14,500	1.81	IMPACT	3 INTER-CONN.	3.75	MOTOR 8	78-82	TURBULENT	2	—	COAL STREAM	195	—	BURNER	225	—	—	—	—	—	—	—	—	—	—	—	—
INDIANA BOYS SCHOOL	1,800	100 WORKING PRESSURE	395	IND. BITUMINOUS 11,500	—	—	—	—	—	—	—	—	—	—	—	—	—	—	U.F.	35		44.22	STEAM	1		—	—	0.5 AVERAGE	318	
MICHIGAN LIMESTONE & CHEMICAL CO.	8,800	415	3,000	PITTS GAS	2.0	—	—	—	—	—	—	—	—	—	—	—	—	—	U.F.	50	46	182.6	2 SPEED MOT	8	29			6.0	300	80,000
INDIANAPOLIS HOSPITAL	5,128	74.7	1,387	IND. BITUMINOUS 11,000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	C.G.		39.45-1	130	ENG. & MOTOR			L-13 W-10	6	—	—	—
YOUNGSTOWN SHEET & TUBE CO	20,283	430	20,500	B. FURNACE GAS 50 PER CU.FT PULV COAL	—	IMPACT BIN SYSTEM	2 FOR 8	15	200 HP. MOTOR	—	GAS ASPIRATOR COAL SHORT FLAME	—	—	BURNERS	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MONTHORNE WESTERN ELEC	12-7,775	175	1,900	IND & ILL. BIT 11,000	10	—	—	—	—	—	—	—	—	—	—	—	—	—	C.G.	50	40.3	178.3	VAR. SPD. D.C. MOT & WORM GEAR	—	—	L 17 W 10.3	6	2.5	70	160,000
KEARNY WESTERN ELEC	8,400	300	1,720	PA. BALEY 12,500	5	—	—	—	—	—	—	—	—	—	—	—	—	—	C.G.	46.7	35.9	234	MOTOR	— —	8	L-23.75 W 10.75	8	5	70	—
WORLD CLEANERS & DYERS	2550	185	—	FUEL OIL	—	—	—	—	—	—	HEAVY DUTY	2	—	BURNER	—	—	BURNER	—	—	—	—	—	—	—	—	—	—	—	—	—

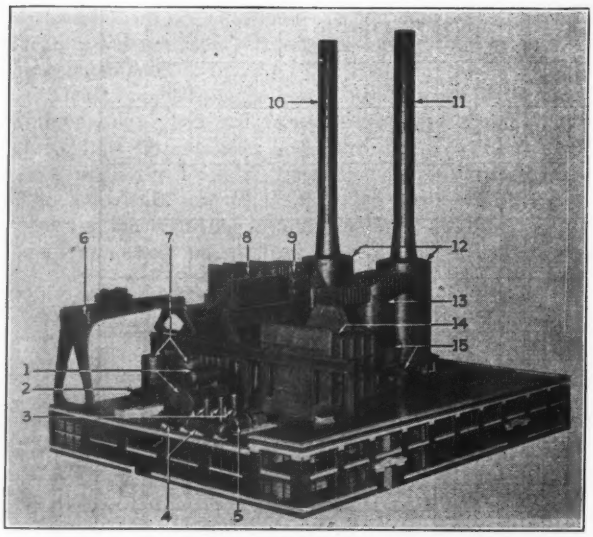


FIG. 2. MODEL OF SCHENECTADY MERCURY-VAPOR PLANT

1—Deaerator. 2—Mercury turbine-generator. 3—Feedwater heaters. 4—Evaporators. 5—Steam turbine-generator. 6—Gantry crane. 7—Condenser boilers. 8—Mercury boiler. 9—Air preheater. 10—Mercury boiler stack. 11—Steam boiler stack. 12—Cylinders containing induced draft fans and coal bunkers. 13—Air preheater. 14—Steam boiler. 15—Forced draft fans.

designed for welding, which have had many interesting applications, particularly in industrial plant work. Welding technique, methods of instructing welders, testing methods for welds and welding equipment itself have all been improved during the year and there is every indication that the method will be applied in even more varied and useful ways in the future. Installation of main steam headers near the operating floor, where valves may be easily reached, has proved a convenient feature in many of the newer plants.

Prevention of Air Pollution

In view of the current agitation about atmospheric pollution, power plant engineers in central stations and industrial plants have taken the lead in rendering their own plants free from criticism even though they are seldom responsible for any appreciable amount of air pollution when compared with that produced by domestic fuel-burning installations. A great deal of research has been carried on not only to prevent dust emission from power plants but also to recover any dust that does escape and even to make some commercial use of it. Smoke and soot washers of several types, cinder catchers, precipitators and other equipment for removing dust from boiler stack gases and cyclone vents have been installed during the year. While the costs of these methods are sometimes high, the improvement in public relations is generally held to justify these costs.

Typical of the measures necessary to prevent air pollution when a power plant is located in or near a residential district is the equipment installed at Glenwood Station on Long Island, described in the Oct. 15, 1931, issue of Power Plant Engineering. In the coal pulverizing plant, where the central or bin system is employed, air separated from the coal in the cyclones is filtered and boiler flue gas is cleaned by electrostatic precipitators

In a new coal pulverizing plant installed this year at Gould St. Station in Baltimore, air vented from the cyclone separators is cleaned by dust collectors, the recovered dust being sent to the boilers. The outstanding features of this system are that mill, cyclone and dust collectors operate under vacuum to prevent coal dust leakage and the air used for mill drying of coal is heated in a steam air heater.

Use of Mill Drying Increases

In addition to Gould St., several other important stations report use of mill drying for coal, with satisfactory results. As far as the available data show, the separately-fired coal dryer for power plants has been practically abandoned in favor of mill drying. According to the N.E.L.A., St. John's Station in New Brunswick has dried coal containing 10 to 12 per cent moisture in a ball and tube mill. Milwaukee Electric Railway and Light Co. reports satisfactory results and no cases of spontaneous combustion although gas temperatures of 550 deg. and wind box temperatures of 350 deg. have been used. Narragansett Electric Co. states that it has reduced moisture of coal from 4 to 1½ per cent using room air in the mills. At both South Amboy (described last year) and Bremo, premeasured and preheated air are used to dry coal in the mills.

During the year some pulverized coal burners of high capacity have been developed. Ohio Edison Co. reports data on burners having a range of heat release from 48,000,000 to 109,000,000 B.t.u. an hr. Consolidated Electric Light & Power Co. has made improvements on burners to give better flame penetration into the furnace. At the West Virginia Pulp & Paper Co.'s Piedmont plant, a burner has been used that produces from 45,000 lb. to 135,000 lb. of steam an hour, an operating range of 1 to 3, with indications that the upper and lower load limits could be increased so far as the burner is concerned. The maximum heat liberation of this burner is stated to be over 200,000,000 B.t.u. an hour

Many engineers are interested in the possible effect that the recent natural-gas pipeline developments may have on the fuel-burning problem but this development is too new to permit valid predictions on this point.

Use of water-cooled furnace walls both in pulverized-coal-fired and stoker-fired furnaces, seems to be firmly established as general practice. One outstanding excep-

FIG. 3. AT TUCO STATION, 7500-KW. TURBINE GENERATOR AND BOILERS IN SAME ROOM ILLUSTRATE TENDENCY TO SIMPLIFICATION BY ELIMINATING DIVIDING WALL

tion noted in this year's review is Ashtabula with completely air-cooled walls and a hearth screen but this station was designed under unusual conditions, based on the principles used at Avon. At the Glatfelter plant, because of the necessity for operating at 50 per cent of rating over week ends, water-cooled back wall and air cooled side walls were used to assist in maintaining combustion. On the whole, the water-cooled furnace has been generally accepted on account of many operating and design advantages. One of its principal effects is to cause some decrease in effective furnace volumes in new designs or increase of capacity in existing units. This is shown on the table of furnace data.

SUPERHEATER, ECONOMIZER, AIR PREHEATER

STATION	COMBINED HEATING SURFACE SQ.FT. PER UNIT	SUPERHEATERS: BOILER PRESS. ABS.	TYPE	HEATING SURFACE PER BLR. SQ. FT.	HEATING SURFACE PER BLR. % B.H.S.	ELEMENTS DIA. IN.	ELEMENTS B.W.G. NO.	TEMP TOTAL DEG. F.	CORRESPONDING BOILER OUTPUT	ECONOMIZERS: TYPE	HEATING SURFACE SQ.FT.	HEATING SURFACE % C.H.S.	LOCATION	TEMPERATURE WATER IN	TEMPERATURE WATER OUT	TEMP GAS IN	TEMP GAS OUT	AIR PREHEATERS: TYPE OF AIR PREHEATER	NO. PER BOILER	HEATING SURFACE SQ.FT. EACH	CAPACITY LB. AIR PER HR. TOTAL	AIR TEMPERATURE IN	AIR TEMPERATURE OUT	GAS TEMP. IN	GAS TEMP. OUT
BREMO	21,674	540	CONV.	—	—	—	—	825	200,000	EXTENDED SURFACE	16,128	— HEAT	ABOVE BOILERS ABSORBING ELEMENT	D.P.O. SOLUTION 126	500	633	325	X-FIN TUBES	PRIM.-3 SEC.-3	2,170 6,108 HEAT LIBERATING UNITS	63,000 148,000	70 70	340 427	DIPHENYL 425 900	DIPHENYL 120 120
RARITAN RIVER	16,256	455	CONV	2540	20.5	—	—	725	190,000	WATER	3,840	23.6	ABOVE BOILERS	290	348	620	605	ROTARY ELEMENT	1	17,800	—	100	350	605	434
RIVERSIDE	15,646	415 AT SUPERHTR. OUTLET	CONV. & RADIANT	3,350	18.8	2	7 RAD.	1-738 1 750	250,000 200,000	COUNTER CURRENT	12,096	35.2	BEHIND BOILER	260	380 390	800 714	498 442	— NONE —							
ASHTABULA	32,850	395	CONV.	6,778	20.8	2	10	730-760	290,000 416,000	WATER	23,232	71.2	BEHIND BOILER	215 215	358 402	725 840	400 476	PREHEATED AIR FROM AIR COOLED FURNACE WALLS							
HUDSON AVE.	56,536	455 AT SUP. OUTLET	CONV.	5,740	23.5	2	8	750	464,000	RETURN BEND	22,400	39.6	ABOVE BOILERS	270.7	390	825	485	—	—	—	—	—	—	—	—
TUCO	—	290	CONV.	1,640	—	2	—	650	81,500	—	—	—	—	—	—	—	—	FLAT PLATE	1	13,430	71,000	80	399	565	300
TRINIDAD	—	465	CONV.	6,475	20.0	2	9	750	300,000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MOORES PARK	2-16,762 2-19,608	565 MAX	CONV.	3400 2800	20	1.625	—	700	224,000 259,000	WATER	2-7200 2-6400	43	BEHIND BOILER	266	355	810	548	PLATE	1	2-16,500 2-19,320	236,000 278,000	100	326	548	365
LAKESIDE	28,845	1405	RADIANT	1125	—	2	1	750	250,000	—	—	—	—	—	—	—	—	PLATE	1	77,500	286,000 NORMAL	70	620	755	315
MICHIGAN CITY	29,448	695	CONV.	5,072	70.5	1-7.8	6	770	345,000	STEAMING	14,929	50.7	BEHIND BOILER	388.5	—	1,250	735	TUBULAR	1	42,000	353,000	80	540	735	408
GLENWOOD	27,836	465	RETURN BEND LOOP	5,000	24.9	—	—	800	300,000	—	—	—	—	—	—	—	—	VERTICAL TUBE (GAS)	1	44,825 OUTSIDE TUBES	415,000 MAX	80	573 MAX.	820 MAX.	419 MAX.
P.H. GLATFELTER CO	12,545	365	CONV.	875	7.7	2	11	580	60,000 TO 134,000	C.I. WATER	13,150	115	BEHIND BOILER	242	292	520	362	—	—	—	—	—	—	—	—
M.J. WHITTAL ASSOCIATES	7,228	215	CONV	1,000	19.7	2	11	488	50,000	INTEGRAL	1,093	15.1	REAR INSIDE BOILER	214	269	575	430	—	—	—	—	—	—	—	—
SUNBURY CONVERTING WORKS	17,750	375	—	—	—	—	—	458	150,000	INTEGRAL	4,200	23.7	BEHIND BOILER	200	—	500	310	TUBE	1	12,000	—	98	225	310	225
INDIANA BOYS' SCHOOL	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	ROT. ELEMENT INTGRAL. GAS TURB. DRIVE	1 FOR 2	1,945	9,580	80	318	490	258
MICHIGAN LIMESTONE & CHEMICAL CO	10,472	415	CONV	1,530	17.4	1.625	—	700	50,000	—	—	—	—	—	—	—	—	TUBULAR	1	4,555	73,700	70	250	600	455
INDIANAPOLIS HOSPITAL	NONE																								
YOUNGSTOWN SHEET & TUBE CO.	20,283	430	CONV.	—	—	—	—	700	180,000	—	—	—	—	—	—	—	—	PLATE	1	20,100	198,000	—	—	—	—
HAWTHORNE WESTERN ELEC	11070	175	CONV	552	7.65	3.5	11	470	60000	INTEGRAL WATER	2740	24.8	BEHIND BOILER	212	310	650	500	—	—	—	—	—	—	—	—
KEARNY WESTERN ELEC	8,400	300	CONV.	874	10.4	1.625	10	700	84,250	INTEGRAL WATER	4,203	—	BEHIND BOILER	212	312	400	325	—	—	—	—	—	—	—	—
WORLD CLEANERS & DYERS	NONE																								

• C.H.S. = BOILER SURFACE + W.W. SURFACE + INT. ECON. SURFACE, IF ANY.

Diphenyloxide Air Preheater

The fluid air heater at Bremo using diphenyl-oxide (mixed with some napthalene to lower its freezing point) as a heat absorbing and carrying material has attracted much attention during the year and is reported to have operated satisfactorily. It was described in detail in the May 1, 1931, issue of Power Plant Engineering and is shown diagrammatically in Fig. 1. Two principal objects were sought in designing this system; first, elimination of elaborate and expensive ductwork with high draft loss that would otherwise have to be used with the high single-pass, vertical boilers at Bremo; second, a means of controlling primary and secondary air temperatures separately. Because of the mill and fan equipment, limits are set to the temperatures of primary air, whereas with proper materials there seems to be no top limit to secondary air temperature, as this air is usually delivered direct to the furnace. Thus, if both primary and secondary air are heated in one heater, the secondary air temperature is limited to that allowed for the primary air.

Study of Fig. 1 shows how this difficulty is overcome with the diphenyloxide heater. The fluid is circulated by a small pump through the heat absorbing element at the top of the boiler, where it is heated by the flue gas. Through a simple system of 3-in. piping, the fluid then passes to two sets of heat releasing elements, close to mills and furnaces, where the fluid gives up heat to the air.

At Indiana Boys School, a rotary-element type air preheater is used with fans driven by a steam turbine, to insure reliability of boiler operation and to supply exhaust steam for maintaining the heat balance in winter.

All types of air preheaters are being installed in modern stations. There seems to be a tendency toward increasing secondary air temperatures, values of 573 deg. at Glenwood, 620 deg. at Lakeside and 400 to 500 at Michigan City representing latest practice in the larger plants. With stokers, combustion air temperatures of 300 to 350 deg. are shown for four of the stations, although the extremely large new stokers at Hudson Ave. use combustion air at 70 deg.

Pulverized Coal Equipment and Stokers

Although several of the important plants shown in the tables have installed central or bin-systems of pulverized coal equipment, the general feeling among engineers is that installations of unit systems are becoming more numerous than of bin systems. The total amount of coal pulverized by bin systems remains greater, however, than that pulverized by unit systems. Each type

BOILER DATA

STATION	NO.	TYPE	CAPACITY PER BOILER LB. PER HR. NORMAL	CAPACITY PER BOILER LB. PER HR. MAX.	ABSOLUTE PRESSURE LB. PER SQ. IN.	HEATING SURFACE PER BOILER: BOILER SQ. FT. B.H.S.	WATER WALLS SQ. FT.	WATER WALLS % C.H.S.	SUPERHEATER SQ. FT.	SUPERHEATER % C.H.S.	RESUPERHTR. STEAM OR GAS	RESUPERHTR. SQ. FT.	ECONOMIZER SQ. FT.	ECONOMIZER % C.H.S.	APREHTER SQ. FT.	NO. PASSES	FURNACE VOL. CU. FT.	FURNACE VOL. CU. FT. PER SQ. FT. C.H.S.	TUBE BANK WIDE	TUBE BANK HIGH	DRUMS NO.	DRUMS TYPE	DRUMS STEAM DIA.	DRUMS STEAM LENGTH
BREMO	2	HOR. CROSS DRUM ●	160,000	200,000	540	19,836	1,838	8·5	—	—	—	—	—	—	16,128 ▲	1	9,400	0·434	30	39	1	RIVETED	54″	20′-1 3/4″
RARITAN RIVER	4	HOR. CROSS DRUM	112,000	190,000	455	11,810	606·5	3·7	2,540	15·0	—	—	3,840	23·6	17,800	3	6,500	0·40	42	17	1	RIVETED	54″	
RIVERSIDE	3	STR. TUBE	200,000	250,000	415	17,740	1,066	3·11	3,350	9·8	—	—	12,096	35·3	—	3	10,600	0·31	56	18	1	FORGE WELD.	54″	31′-8 1/2″
ASHTABULA	6	TWIN VERT. BENT TUBE	280,000	416,000	410	32,560	980	2·9	6,778	20·2	—	—	23,232	69·3	—	4	32,560	0·971	55	34	8 ●	RIVETED	STM. 42″ MUD 48	34′-4″ 29′-3 3/8″
HUDSON AVE.	8	CR-DRUM SEMI-VERT. BENT TUBE	464,000	530,000	455	24,450	3,846	6·8	5,740	10·2	—	—	22,400	39·6		3	14,000	—	39 48 50	6 6 7	4	FORGED	48″	26′-0″
TUCO	2	SECTION CR-DRUM W-TUBE	54,300	81,500	290	7,873	—	—	1640	17·2	—	—	—	—	13,430	2	2,750	0.289	24	15	1	RIVETED	48″	18′-11 3/4″
TRINIDAD	2	SECTION CR-DRUM W-TUBE ●	300,000	325,000	465	32,047	5,485 W.W.& HEARN SCREEN	12·5	6,475	14·7	—	—	—	—	—	1	19,500	0·44	44	43	1	RIVETED	60″	33′-9″
MOORES PARK	4	4 DRUM BENT TUBE		2-224,000 2-258,000	585	15,950 16,760	812 846	4·8 4·9	3,600 3,900	20	—	—	7,200 8,400	43	16,500 16,320	3	8986 10,389	0·53	39 46	20	4	MUD-E&H WELD OTHERS RIVETD	48″ 42″	—
LAKESIDE	4	VERT. BENT TUBE	250,000	300,000	1,405	23,640	W.W.& W.S. 5,205		1,125	—	GAS	7,800	—	—	77,500	4	28,573	—	70	—	3	FORGED	50.5″	41′-6″
MICHIGAN CITY	3	CR. DRUM	275,000	345,000	695	7,187	2,250	7·62	5,072	17·2	—	—	14,929	50·7	42,000	1	14,700	0·499	40	8	1	FORGED	52″	40′-3″
GLENWOOD	4	CR-DRUM ST. TUBE	60,000	300,000	465	20,036	2,600	9·4	5,000	18·1	—	—	—	—	44,925	2	11,700	0·424	38	20	1	RIVETED & ELECT. WELD.	54″	31′-8 1/4″
P. H. GLATFELTER CO.	2	ST. TUBE CR. DRUM	80,000	134,000	385	11,380	290	2·5	875	7·7	—	—	13,150	115	—	3	6,500	0·571	27	18	1	RIVETED	54″	23′-0″
M. J. WHITTAL ASSOCIATES	3	VERT. TUBE	30,000	50,000	215	5,063	72	1	1,000	13·8	—	—	1,093	15·1	—	3	1,500	0.207	188	188	32	RIVETED	54″	14′-0″
SUNBURY CONVERTING WORKS	2	BENT TUBE	75,000	150,000	375	8,250	5,300	3·0	—	—	—	—	4,200	23·7	12,000	6	8,600	0·484	25	—	6	RIVETED	38	16′—8″
INDIANA BOYS SCHOOL		3 DRUM LOW HEAD INCL.			160	1,800 EA.	—	—	—	—	—	—	—	—	1,945	3	398	—	16	11	3	RIVETED	38	6′- 8″
MICHIGAN LIMESTONE & CHEMICAL CO.	3	3 DRUM BENT TUBE	55,000	80,000	415	8,797	145	1·38	1,530	14·6	—	—	—	—	4,555 ■	4	3,000	—	29	—	3	RIVETED	48″	21′-0″
INDIANAPOLIS HOSPITAL	3	STIRLING	17,698	53,094	174.7	5,128	—	—	—	—	—	—	—	—	—	3	1,386	0.27	20	—	4	RIVETED	▼	11′-9 1/2″
YOUNGSTOWN SHEET & TUBE CO.	6	VERT. BENT TUBE	60,000	180,000	450	20,283	—	—	—	—	—	—	—	—	—	3	20,500	1·0	—	—	4	RIVETED	48″	—
HAWTHORNE WESTERN ELEC.	12	INCL. BENT TUBE		60,000	175	7,213	565	5·1	552	4·98	—	—	2,740	24·8	—	3	1,900	0·17	441	—	3	RIVETED	48″	11′-4 1/2″
KEARNY WESTERN ELEC.	2	VERT. BENT TUBE	2555	89,250	300	8,600	—	—	872	—	—	—	4,203	—	—	3	1,720	—	21	17	3	RIVETED	48″	12′- 6″
WORLD CLEANERS & DYERS	2	LONG. DRUM	7,650	19,000	165	2,550	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

▲ HEAT ABSORBING ELEMENT ● 6 STEAM 2 MUD. ■ AIR PREHTR NOT FIGURED IN COMBINED HTG SURFACE ▼ UPPER FRONT 36 IN. CENTER & REAR 42 IN. & MUD 48 IN.
● VERTICAL SINGLE PASS TYPE, GAS PASSAGE TAPERING SEE CROSS SECTION

has its adherents and there is still considerable controversy about their merits, especially for the larger plants. Many special conditions influence the design; for example, at Youngstown Sheet & Tube Co., where blast furnace gas is the main fuel with pulverized coal as the auxiliary, flexibility of control of coal was the primary consideration. In all these comments it should be remembered that size of plant, load conditions, fixed and operating charges, operating conditions, type of fuel and many other factors must be considered in choosing between the two systems and that each has its proper application.

Developments in details of stokers have proceeded during the year, leading to lower maintenance and better performance. Some large units have been installed such as those at Hudson Ave., 26 ft. 7 in. long and 26 ft. wide.

Heat Liberation

Most engineers express themselves in favor of moderate rates of heat liberation both in pulverized coal and stoker fired furnaces. The values given on the furnace table are mostly maximum values, of course. For the pulverized coal furnaces, these values vary widely, from 12,562 B.t.u. per cu. ft. per hr. at Youngstown to 43,720 at Glenwood. Other values, however, that are considered more representative of the general trend are: Bremo, 26,200; Tuco, 28,000; Trinidad, 25,000; Michigan City, 29,350; Sunbury, 18,900; all at maximum steam output. These values are a little higher than those used two or three years ago.

For the stoker plants, heat liberation values run higher than for pulverized coal plants, ranging from 21,500 B.t.u. per cu. ft. per hr., at Whittal plant to 54,770 at Hudson Ave. for underfeed stokers and up to 79,200 B.t.u. for the chain grate units at Kearny.

Several interesting installations of low-headroom water-tube boilers have been made in industrial plants during the year. This is a trend that should prove of advantage to industrial power engineers who are faced with the necessity of remodeling of plants and increasing capacity, especially where expansion of buildings is either extremely costly or physically difficult.

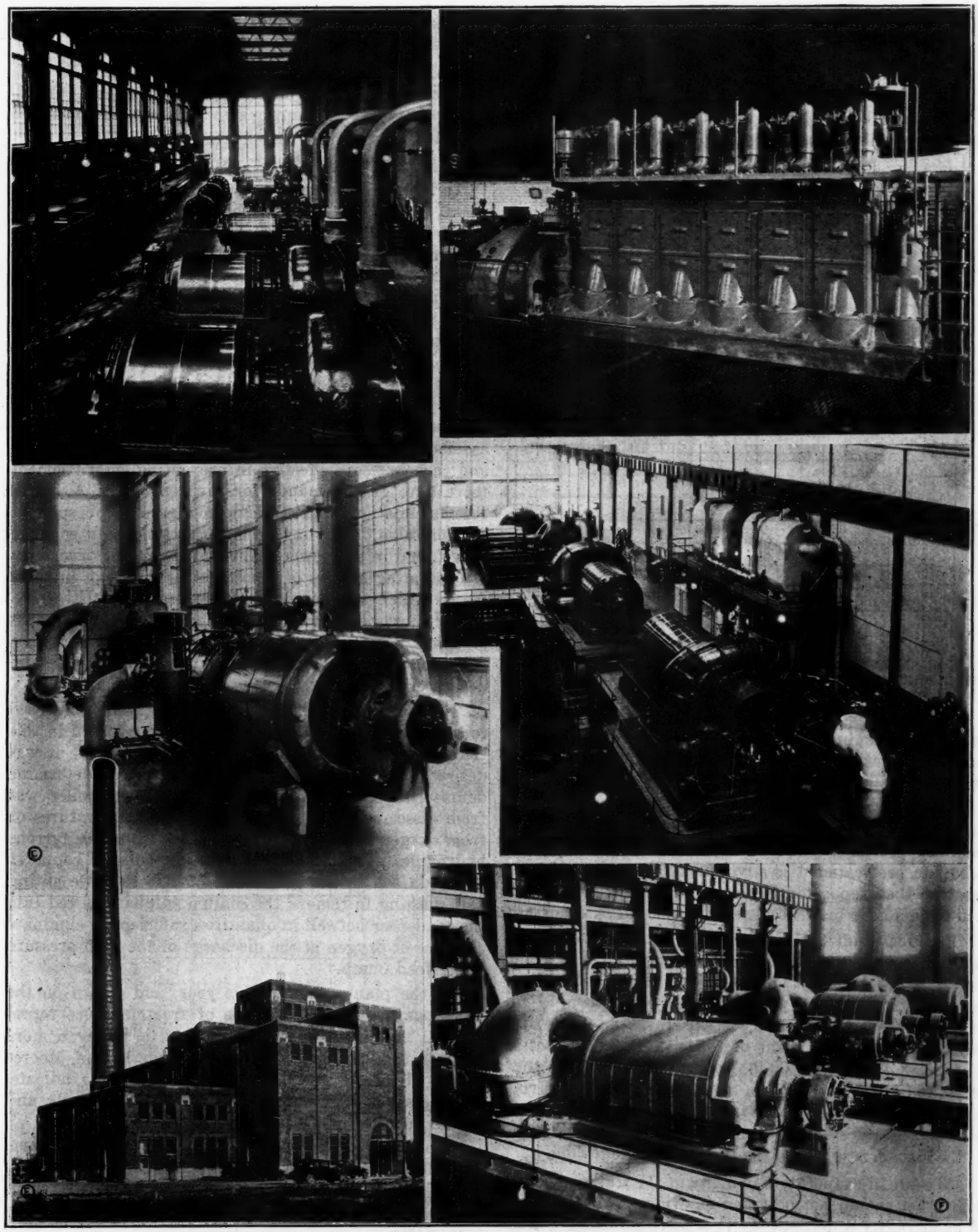
Centralized Control

Centralized control of complete power plants has been discussed during the past year, in view of the successful use of it by Bremo and one or two other stations. At Bremo, all controls for boilers, turbines and electrical equipment are centered in three boards in a control room on the operating floor between turbines and boilers. There is no dividing wall between boiler and turbine rooms. This control room is shown elsewhere in this issue. A complete, detailed description of the controls was published in the May 1, 1931, issue of Power Plant Engineering.

Another splendid example of centralized control of boilers (not of the entire plant) is at Moores Park, where all boiler and combustion controls are handled from a control room overlooking the firing aisle.

While Bremo is the one outstanding example of complete centralized plant control, many engineers believe that since the necessary equipment for these controls is now available, there is no reason why centralized control cannot be used if the economic factors warrant it.

Typical 1931 Power Developments

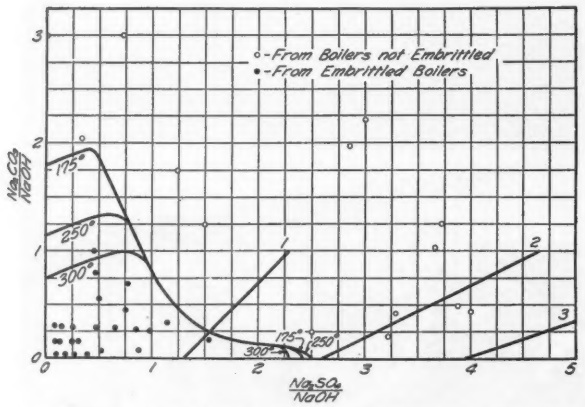


A. A general view of the turbine room at the Hawthorne plant of the Western Electric Co. B. A unit in the Diesel electric plant of the Dennison Mfg. Co. C. An excellent example of industrial plant practice is that of the M. J. Whittal Associates, the turbine room of which is shown here. D. The turbine room of the Riverside Station of the Northern States Power Co. E. The plant of the Indianapolis City hospital. F. The turbine room at Trinidad Station.

Feedwater Treatment Shows Advancement

PHYSICAL AND CHEMICAL ASPECTS OF SCALE, CORROSION AND EMBRITTLEMENT NOW BETTER UNDERSTOOD. ALL TYPES OF EQUIPMENT REACH HIGH STATE OF DEVELOPMENT

FOR THE FIRST TIME since the introduction of the steam boiler the feedwater treatment problem is apparently on the road to solution. Both the chemical and physical significance of scale, corrosion and embrittlement are now better understood and equipment is available for taking advantage of this knowledge in a practical way. Lime and soda ash, and zeolite softeners continue to be favorites in the majority of cases, often assisted by auxiliary chemical and coagulant agents such as sodium aluminate. Extensive use of evaporators for supplying makeup has not appreciably affected the use of treatment equipment.



RATIOS NECESSARY TO PREVENT EMBRITTLEMENT. THE SMALL AREA UNDER THE CURVE IN THE LOWER LEFT HAND CORNER REPRESENTS DANGEROUS CONDITIONS

In order to reduce carryover with the evaporator vapor while maintaining a reasonable capacity and to facilitate cracking and cleaning of the evaporator coils adequate pretreatment is advisable[1]. The object of pretreating the evaporator feed is to produce a water that will form a hard brittle scale easily removed by cracking.

Practically all the high-pressure stations use evaporated makeup, supplied either from evaporators or from low pressure boilers. This is by no means limited to central stations and probably the best example of evaporator practice, in the stations reviewed this year, is in the new power plant of the Youngstown Sheet & Tube Co.[2] Here the 400-lb. boilers, high-pressure turbines and evaporators are in a closed circuit. Industrial and process steam and high-pressure boiler makeups are supplied by the evaporator at 150 lb. The flow diagram of the station is shown in the third article following.

Absence of evaporators in many of the stations in this year's list should not be taken as evidence that the use of evaporators is decreasing. It is mere coincidence that between the stations completed in 1930 and those to be completed in 1932, are many low-pressure plants fortunate to have a water supply susceptible to easy chemical treatment.

EMBRITTLEMENT AND CORROSION

In the field of embrittlement, a battle field for many years, Straub[3] rendered signal service to the field with a bulletin outlining the history of embrittlement, industrial experience to date and a summary of laboratory experiments. Causes and prevention of embrittlement are covered in considerable detail and the recommendations of the A.S.M.E. boiler code proven valid but perhaps unduly narrow. His recommendations for embrittlement protection are shown by the accompanying curves with the 1, 2 and 3 ratios of the A.S.M.E. indicated by the three diagonal lines. In a few instances, the A.S.M.E. ratios have been difficult to maintain and as laboratory tests show that salts other than sulphate and carbonate are effective in preventing embrittlement there have been demands for revision of the A.S.M.E. recommendations[4] particularly in regard to phosphates.

Corrosion due to oxygen is perhaps the most common type found in the power plant and the use of deaerators or deaerating heaters is almost universal except in those plants which maintain a closed system as at Riverside. Under most boiler water conditions an oxygen content of below 0.05 cc. per liter is sufficient to prevent corrosion and this can be had without difficulty by thermal deaerators or heaters.

For this reason, chemical deaerators, which are used to some extent in Europe, have not been adopted in this country except in one known case. At Lakeside it was desired to remove the last trace of oxygen to determine definitely whether slight oxidization in the boiler was from dissociation of the steam at high temperatures or from oxygen in the feedwater. For this purpose ferrous hydroxide, prepared at the plant by mixing copperas and soda ash in the proportion of 1.73 to 1, decanting and washing to remove the sodium sulphate, is fed into the condenser hotwell in quantities sufficient to eliminate all trace of oxygen at the discharge of the high-pressure boiler feed pump.

In the plants covered this year, and shown on the accompanying table, all types of treatment are represented. Treatment of evaporator feed is however, more common than the four evaporator plants Bremo, Moores Park, Glenwood and Michigan City, would indicate. These stations are fortunate in their water supply and should not be interpreted as a trend.

Final feedwater temperatures ran to about the same maximum temperatures as last year, that is 375 to 400 deg. F. It is interesting to note that the highest temperature, 400 deg. F. at Michigan City, is used with an economizer.

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[1]See Power Plant Engineering, Industrial Evaporator Practice and Design, By S. E. Tray, p. 751, July 15, 1931.

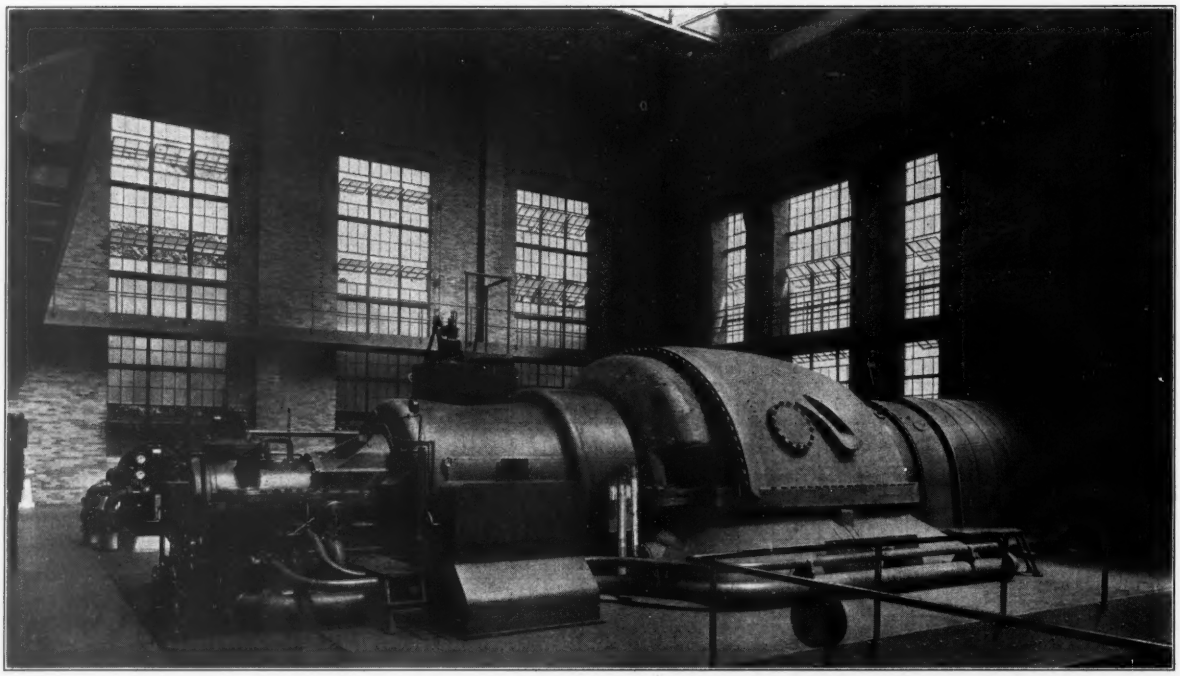
[2]See Power Plant Engineering, Youngstown Sheet & Tube Modernizes Its Power Plant, p. 874, Sept. 1, 1931.

[3]See Power Plant Engineering, p. 190, Feb. 1, 1931, for abstract of Univ. of Illinois Bulletin No. 216.

[4]See Power Plant Engineering, Significance of Alkalinity in Embrittlement Studies. Hecht and McKinney, p. 602, June 1, 1931, and reply by Straub, p. 1136, Dec. 1, 1931.

FEEDWATER TREATMENT AND HEATING

STATION	TREATMENT							HEATING			STAGE WATER HEATING TEMPERATURE DEG. F.																					
	SOURCE OF MAKE-UP	SYSTEM	IS WATER TO EVAP TREATED?	EVAPORATORS				SOURCE	TYPE HEATER	FINAL FEED TEMP. DEG. F.	EJECTOR		OIL COOLER		GEN. AIR COOLER		DEAER. HEATER		EVAP.		EXTRACTION HEATERS										ECON.	
				EFFECTS 1 OR 2	STEAM PRESS. TO EVAP. LB.	LOCATION EVAP. AND COND.	CAPACITY LB. PER HOUR														NO. 1		NO. 2		NO. 3		NO. 4		NO. 5			
											IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT
BREMO	RIVER	EVAP.	NO	1	65	BLR. ROOM BASEMENT	5000	EXTR.	OPEN	382	79	88	—	—	—	—	—	—	236	263	86	151	151	236	263	298	298	382	—	—	—	—
RARITAN RIVER	CITY & DEEP WELL	SODA ASH & PHOSPHATE	—	—	—	—	—	EXTR	2 CLOSED 1 OPEN	291			—	—			160	235	—	—	94	163	—	—	235	291	—	—	—	—	290	346
RIVERSIDE	RIVER	NONE	NO	1 OR 2	62	BLR. ROOM BASEMENT	2 EFFECT 5000	EXTR. & AUX. EXH.	CLOSED	287	91	95	—	—	80	91	—	—			95	164	164	232	232	287	—	—	—	—	287	400
ASHTABULA	LAKE ERIE	NONE	—	—	—	—	—	EXTR. & AUX. EXH.	2 CLOSED 1 OPEN	215	89.2	94.3	—	—	79.1	89.2	191.7	215	—	—	94.3	144.0	144.4	191.7	—	—	—	—	—	—	213.0	358
HUDSON AVE.	CITY WATER	CHEMICAL	—	—	—	—	—	EXTR.	CLOSED	270.7	77	78.5	—	—	78.5	85.6	—	—	—	—	85.6	198	199.7	270.7	—	—	—	—	—	—	270.7	390
TUCO	DEEPWELLS	COLD PROCESS LIME & SODA ASH	—	—	—	—	—	EXTR & AUX EXH.	OPEN	204			—	—	—	—	75	204														
TRINIDAD	RIVER	ZEOLITE	YES	1	86	HTR. BAY	8600	EXTR.	CLOSED	341	108	111	105	108	96	105	253	268	268	278	111	172	172	190	190	253	278	341				
MOORES PARK	RIVER	EVAP.	NO	1	46 TO 189	BLR. ROOM FLOOR	12 450	EXTR.	CLOSED & DEAER.	286	92.5	98.5	—	—	79	92.5	144	224			98.5	144	DEAER	HTR	224	266	—	—	—	—	266	355
LAKESIDE	LAKE	CHEMICAL	—	—	—	—	—	EXTR.	CLOSED	321	68	70	—	—	70	80	—	—	—	—	80	146	146	194	194	264	264	321	—	—	—	—
MICHIGAN CITY	LAKE	EVAP.	NO	1	39	AUX. PUMP ROOM FLOOR	30 000	EXTR.	CLOSED	400	77	84	NOT	IN	HEAT	CYCLE	—	—	163.7	198.3	84	163.7	198.3	255.8	255.8	334.7	334.7	398.5	—	—	398.5	STM.
75 000 GLENWOOD 25 000	DEEPWELLS	EVAP.	NO	1	152 138	BASEMENT	30 000 8 250	EXTR.	CLOSED	342 350	—	—	—	—	—	—	158 186	243 253	243 253	262 355	78 91	156	DEAER	HTR	282	342 350	—	—	—	—	—	—
R.K.GLATFELTER COMPANY	CREEK	ZEOLITE	—	—	—	—	—	AUX. EXH. & EXTR.	DEAER.	212	—	—	—	—	—	—	—	—	—	—			—	—	—	—	—	—	—	—	212	292
M.J.WHITTAL ASSOCIATES	RESERVOIR	FILTERED	—	—	—	—	—	EXH.	DEAER.	214			—	—	—	—		214	—	—			—	—	—	—	—	—	—	—	214	269
SUNBURY CONVERTING WORK	RIVER	ZEOLITE	—	—	—	—	—	EXH.	DEAER	200	—	—	—	—	—	—	80	200	—	—	—	—	—	—	—	—	—	—	—	—	200	
INDIANA BOY'S SCHOOL	WELLS	LIME & SODA ASH	—	—	—	—	—	EXH.	OPEN	210	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MICHIGAN LIMESTONE & CHEMICAL CO.	LAKE	ZEOLITE	—	—	—	—	—	EXTR.	CLOSED	230	79	85	—	—	—	—	—	—	—	—	85	181	181	230	—	—	—	—	—	—		
INDIANAPOLIS HOSPITAL	DEEP WELLS	HOT PROCESS	—	—	—	—	—	EXH.	DEAER.	210	—	—	—	—	—	—	140	210	—	—	—	—	—	—	—	—	—	—	—	—	—	—
YOUNGSTOWN SHEET & TUBE CO.	RIVER	FILTERED	NO	1	415	BLOWER ROOM	FROM INDUST. SYS.	EXTR.	CLOSED	350	—	—	—	—	—	—	—	—	—	—									—	—	—	—
HAWTHORNE WESTERN ELEC.	CITY	INTERNAL	—	—	—	—	—	EXTR.& AUX. EXH.	DEAER	212								212	—	—	—	—	—	—	—	—	—	—	—	—	212	
KEARNY WESTERN ELEC.	CITY WATER	CHEMICALS	—	—	—	—	—	EXH.& EXTR.	OPEN	212	—	—	—	—	—	—	90	212	—	—	—	—	—	—	—	—	—	—	—	—	—	—
WORLD CLEANERS & DYERS	CITY	CHEMICALS	—	—	—	—	—	—	OPEN	212	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—



The Turbine Room at Moores Park Station.

Turbine Room Practice in 1931

DURING THE PAST YEAR a number of important turbine installations, which are bound to have considerable influence on future developments, were made. Of these perhaps the most spectacular is the 110,000-kw., 1200-lb., steeple compound unit at River Rouge. This is not only the largest industrial turbine unit yet built but is the largest 1200-lb. unit for any service. It consists of two 55,000-kw. units one above the other with a throttle pressure of 1200 lb. and a reheat pressure of 80 lb. at the crossover connection. Steam reheaters are used.

Although this unit illustrates the high degree of proficiency attained by the turbine manufacturers, it does not have the potential possibilities of the 10,000 kw., 1000 deg. F. turbine at Delray No. 3. In this latter machine, the high temperature blades have been installed and the temperature has been gradually raised to the designed 1000 deg. F. By next fall results of the high temperature operation should be available and if successful, as there is every reason to believe they will be, the machine will have far reaching effects on plant design.

A number of companies have not, however, felt it necessary to await these results and at least three stations are under construction for temperatures of 800-850 deg. They are Port Washington, Sheboygan and State Line. Port Washington with 80,000 kw. capacity in a single turbine and single boiler utilizing radiant reheaters will be the first important step toward what has been predicted as the future unit power plant. All three of these plants have, however, been preceded by Bremo Station, designed for 825 deg. F. This station, with its many innovations, is the outstanding station of the year.

Even in the standard pressure and temperature range of 625 lb., 750 deg. F., a new record has been set by Waukegan Unit No. 5, a 115,000-kw. single shaft reheat unit. The turbine exhausts to an 80,000-sq. ft. condenser.

Another distinct development was the 15,000-kw., 3600-r.p.m. turbine design as installed at Bremo Station. Although 3000 r.p.m. machines up to 45,000 kv.a. were in service in Europe as early as 1930, 3600 r.p.m. turbo-generators as demanded by American 60 cycle practice were here held to comparatively small sizes. The high pressure elements of the Deepwater turbines and the back pressure turbines at Louisiana Steam Products approximated the Bremo turbines in speed and size but as they do not expand the steam to condenser pressure they cannot be considered so important because they do not have the design problems of the long low pressure blades to deal with. This high speed offers substantial savings in material, weight and space requirements.

Industrial plants will, of course, benefit from the high pressure and high temperature central station developments but developments of primary interest to them is equipment for the regulation of multi-extraction turbines. With the higher extraction pressures, operation of the generators in parallel with other machines and more exacting demands from process equipment, control requirements for industrial turbines are as diverse as plants and processes using them. Pressure

control, frequency control and load equipment are all available and in wide use.

A new double bleeder compensator which will maintain constant pressure at two extraction points and vary the admission of steam to the throttle according to electrical load demands was described on page 353 of the March 15, 1931, issue. Each bleeder stage is provided with a pressure regulator identical in principle with the speed control governor. The newly developed bleeder compensator is the heart of the system and consists essentially of three relief valves, communicating with the speed and both bleeder mechanism relays. Each of these valves is in turn connected through levers to two diaphragms subjected to pressure by the bleeder pressure relief valves. As may be seen from the diagram, these are so piped that a change of pressure at either bleed point affects the other bleed point as well as the speed governor while any change in the main governor, due to a change in load, is communicated to both bleed points to cause changes in the bleeder operating mechanism.

The mercury-steam cycle has also aroused interest in both industrial plants and central stations and two plants are now under construction, one at the General Electric Co. works, the other for the Public Service Electric & Gas Co. at Kearny station. Both of these will use 20,000-kw. mercury turbines.

From the standpoint of size it is impossible to predict the future limit of turbo-generators. By splitting the machine into several sections with steam or gas reheat between there is little doubt that the present 208,000 kw. unit could be exceeded by at least 50 and maybe 100 per cent if load conditions would warrant. Judging from the trend during the past two years however, such load conditions do not exist even in the Chicago and New York districts, so that units of from 100,000 to 160,000 kw. appear to be the most practical.

There are also certain space and arrangement advantages to the tandem-compound, single-shaft units that increase their popularity. Construction of single shell condensers to handle the exhaust steam, over 1,500,000 lb. per hr., offers further advantages of installation which will probably tend further to increase the popularity of the single shaft machine.

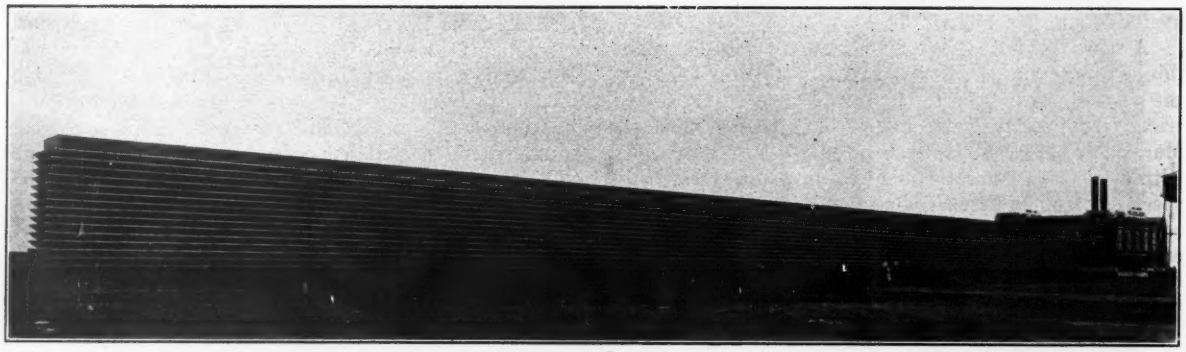
Extraction of up to and exceeding 25 percent of the steam flow to the throttle at pressures of up to half the initial pressure, comes close to exhausting the theoretical possibilities of the extraction cycle and it is not likely that fuel prices will ever be high enough to warrant the use of more than five stages of extraction heating.

There is however, an increasing demand from industrial plants for multiple bleeder turbines. Many of these plants are able to utilize practically all of the steam for process and operate at thermal efficiencies impossible of attainment for the central station. Furthermore these high efficiencies are not limited to large plants of central station proportions. Small turbines have been developed which approach closely the water rates of the larger machines while for the very small plants engines are available to even better the large turbine efficiencies when operating under the same conditions. Space requirements of the larger engine sets are somewhat of a disadvantage, although the new vertical units require an unbelieveably small floor area.

STEAM TURBINES

STATION	NO. & RATED CAPACITY MAIN TURBINE KW.	GENERATOR RATING KW.	DIRECT CONNECTED EXCITER KW	SHAFT GENERATOR KW.	TYPE TURBINE	SPEED R.P.M.	STEAM CONDITIONS: THROTTLE LB. ABS.	THROTTLE DEG. FAHR.	REHEAT AT LB. ABS.	REHEAT AT DEG. FAHR.	EXHAUST LB. ABSOLUTE OR INCHES VACUUM	STEAM FLOW TO THROTTLE AT RATED LOAD	TOTAL LB. PER HR.	PER CENT TOTAL TO THROTTLE	EXTRACTION AT RATED LOAD: FIRST LB. ABS.	FIRST DEG. FAHR.	SECOND LB. ABS.	SECOND DEG. FAHR.	THIRD LB. ABS.	THIRD DEG. FAHR.	FOURTH LB. ABS.	FOURTH DEG. FAHR.	FIFTH LB. ABS.	FIFTH DEG. FAHR.	PURPOSE
BREMO	2-15 000	15,000 AT 80 % P F	65	—	HORIZONTAL TAND. COMP.	3,600	465	62 5	—	—	29	151,430	38,210	25·9	4.14	157	23·8	280	65·9	445	20.5	660	—	—	FEED HEATING & EVAP.
RARITAN RIVER	2-31 500	30 000 AT 80% P F	175 KW. M.G.SET	—	HORIZONTAL 1 CYL	1,800	415	700	—	—	29	300,000	58,500	19·5	6·1	170	23.3	256	64.4	355	—	—	—	—	FEED & STATION HEATING
RIVERSIDE	1- 35,000	35,000	180	—	HORIZONTAL 1 CYL.	1,800	390	725	—	—	29	353,000	78,892	22.3	6.25	171	24.9	239	61.8	294	—	—	—	—	FEED HEATING & EVAP.
ASHTABULA	1-50 000	50,000	200	—	HORIZONTAL 1 CYL.	1,800	390	700	—	—	29	477,000	44,700	9.4	3·5	148	12.9	205	—	—	—	—	—	—	FEED HEATING
HUDSON AVE.	2-160,000	160,000	410	—	TAND. COMP.	1,800	415	730	—	—	27 75	1,590,000	270,100	17	13.30	206	49	329	—	—	—	—	—	—	FEED HEATING
TUCO	1 7,500	7,500	60	—	1 CYL	3,600	250	650	—	—	27.5	85,700	6,500	7·6	27.4	245	—	—	—	—	—	—	—	—	FEED HEATING
TRINIDAD	1-35,000	35,000 AT 80 % P F	175	—	1 CYL	1,800	415	750	—	—	28.25	388,240	84,000	22	7.5	130	35	281	132	487	—	—	—	—	FEED HTG., EVAP. LIGNITE DRYING
MOORES PARK	1-20,000	20,000 AT 90 %P F	100	—	1 CYL.	1,800	440	700	—	—	29	198,640	32,010	16	3.8	151	18.0	224	40.2	320	189	555			FEED HEATING & EVAP.
LAKESIDE	LP 1-60,000 HP 1- 7,700	60,000 7 700	200 —	— —	1 CYL 1 CYL	1,800 3,600	305 1,200	700 750	— 317	— 725	29.4 315 LB	502,300 250,000	117, 601 ——	23.4 ——	4 1 —	146 —	12.0 —	194 —	43.0 —	264 —	101.6 —	321 —	— —	— —	FEED HEATING & EVAP.
MICHIGAN CITY	1-68,000	68,000	420	—	1 CYL	1,800	650	750	—	—	29	707,000	202,700	28·7	6·5	174	19.0	283	125.7	481	271.5	602	—	—	FEED HEATING & EVAP.
GLENWOOD	1-25,000 1-75,000	20,000 75,000 80% P.F.	— —	— —	1 CYL 1 CYL	1,800 1,800	415	750	—	—	29	230,665 764,250	54,525 183,000	22.8 23 9	5 5.25	162 164	34.1 18·7	258 262	152.2 118	506 330	— —	— —	— —	— —	FEED HEATING & EVAP.
P H GLATFELTR	1 - 3,000	3,000		—	1 CYL		315	500			28						—	—	—	—	—	—	—	—	PROCESS
M.J. WHITTAL ASSOCIATES	1 1,500 1 300	1,500 300	15 5·5	—	1 CYL.	3,600	190	488		—	29	DEPENDS ON PROCESS LOAD	VARIES WITH PROCESS	—	35	VARIES	—	—	—	—	—	—	—	—	PROCESS
SUNBURY CONVERTING WORKS	2-1,250	1,250	16	—	1 CYL	3,600	355	443	—		45 LB	48,300	10,800	21·6	125	344	—	—	—	—	—	—	—	—	PROCESS
INDIANA BOYS SCHOOL	16 X 16		—	—	SIMPLE ENGINE	225	125	SAT.	—	—	20 LB	——	——	——	—	—	—	—	—	—	—	—	—	—	——
MICHIGAN LIMESTONE & CHEMICAL CO	1-6,000	6,000	—	—	1 CYL	3,600	375	700	—	—	29	——	85,100	100	9·87		30.4						--	—	FEED & BLDG. HEATING
INDIANAPOLIS HOSPITAL	2-625	625	13	—	1 CYL	3,600	160	464	—	—	20 LB	22,168	——	—	—	—	—	—	—	—	—	—	—	—	——
YOUNGSTOWN SHEET & TUBE CO	2-18,000	18,000	95	—	1 CYL.	1,800	400	700	—	—	24												—	—	FEED HEATING
HAWTHORNE WESTERN ELECTRIC	2-7,500	7,500	—	—	1 CYL.	3,600	165	466	—	—	27.5	104,600	——	——	—	—	—	—	—	—	—	—	—	—	FEED & BLDG. HEATING
KEARNY WESTERN ELECTRIC	1-10,000	10,000	SEPARATE	——	1 CYL	3,600	290	615	—	—	29	130,000	50,000	38 4	16	215	—	—	—		—	—	—	—	FEED & SYSTEM HEATING
WORLD CLEANERS & DYERS	▲ 1-185 KV-A. U.E. 1-125 KVA. C.E.	185 KV-A. 125KV-A.	SEPARATE	——	SIMPLE	—	150	SAT			20 LB	——													

▲ 1 UNIFLOW ENGINE & 1 COUNTERFLOW ENGINE



Condensers and Condenser Auxiliaries

NEW RECORD IN CONDENSER AND COOLING TOWER SIZE FOR CENTRAL STATION SERVICE; MULTISTAGE CONDENSATE AND HEATER PUMPS; AND NEW AIR PUMP ARRANGEMENT AMONG YEAR'S DEVELOPMENTS

AS WITH TURBINES, the year's list of condenser developments is replete with superlatives. It includes the world's largest condenser and world's largest cooling tower. The latter, shown by the headpiece, is used in connection with the Tuco Station in the Texas panhandle where water is at a premium. The tower is 706 ft. long, has 16 cooling decks in the primary and secondary distributing system, contains 1,000,000 ft. of cypress and is designed to withstand a 70 mi. per hr. wind. From the 36-in. main, water is fed to the distribution systems by 22 6-in. inlet pipes. The normal capacity is 32,500 g.p.m. (max. 40,000) and the tower is designed to cool this water to within 3 deg. F. of the wet bulb temperature with a makeup loss of less than 1 per cent. It is expected that an operating vacuum of 27.5 to 28 in. can be maintained throughout the year. The cooled water is collected in a concrete basin and carried back to the pumps by a 42-in. suction pipe. The tower as now installed will take care of half the ultimate station capacity.

The large condenser in Fig. 1 has a total surface of 101,000 sq. ft. made up of tubes 30 ft. long, an impossible length measured by the standards of even two or three years ago. This condenser is installed under the 160,000-kw. Unit No. 7 at Hudson Ave. and exceeds the surface of the condenser under No. 8 by but 1000 sq. ft. These units set records which will probably stand for several years, not because larger units cannot be built, but because it is not likely load conditions in the immediate future will justify additional units of this size, especially in localities where the condensing surface could not conveniently be split into two or more shells because of limited space.

Condenser tube sizes have apparently been more or less standardized at $\frac{7}{8}$ in. as a compromise between the 1-in., which is easier to keep clean, and the $\frac{3}{4}$-in. size, which gives more surface for a given sized shell. Tubes rolled at each end are increasing in popularity and the

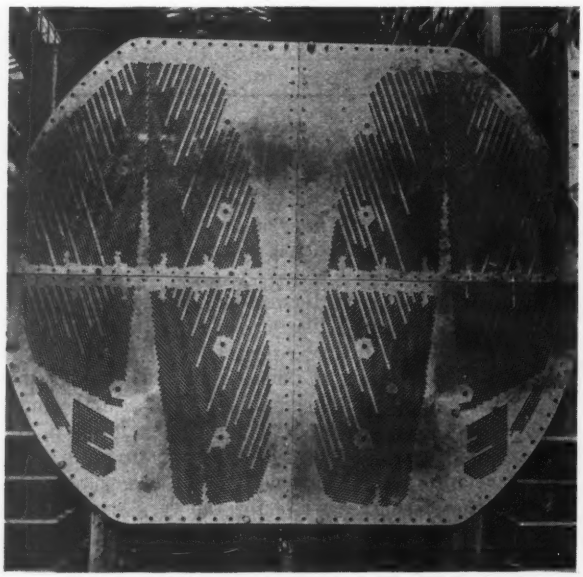


FIG. 1. VIEW OF THE TUBE SHEET OF THE WORLD'S LARGEST CONDENSER, THE 101,000-SQ. FT. UNIT AT HUDSON AVENUE

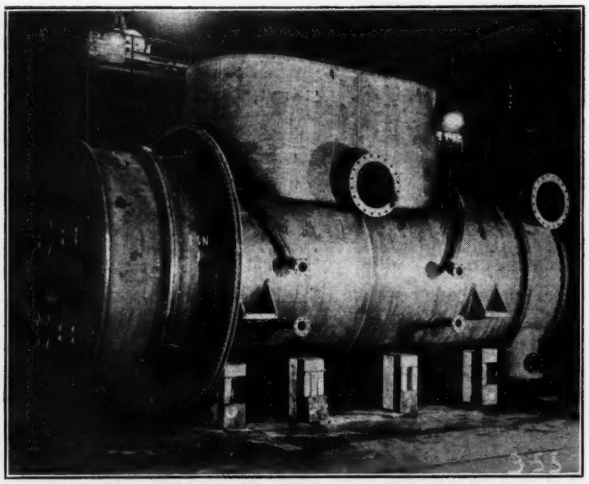


FIG. 2. WELDED SHELL CONDENSER. THE FLANGE AT THE LEFT OF THE EXHAUST CONNECTION IS AN EXPANSION JOINT USED SO THAT THE TUBES CAN BE ROLLED AT BOTH ENDS

majority of those not rolled at both ends are rolled at the inlet and packed with metallic packing at the outlet without the use of ferrules.

Perhaps the factor which will have the greatest influence on condenser development is the introduction and at least limited acceptance of the welded shell. Lighter weight, reduced air leakage and lower costs are responsible for the rapid acceptance of the new designs. One of the smaller sized units is shown by Fig. 2.

additional mention now that its operation has been observed over a considerable period is the combination steam jet and R.D.V. pump at Gilbert Station. Instead of operating steam jet air ejectors supplied with steam at boiler pressure, reciprocating dry vacuum pumps are installed to operate as secondaries to primary steam jet ejectors supplied with low-pressure steam from gland leakage on the high-pressure unit. Under starting conditions, the R.D.V. pumps operate without the

CONDENSERS AND AUXILIARIES

STATION	TURBINE RATING KW.	TOTAL SURFACE IN SHELL		AIR COOLER SECTION		STEAM TO CONDENSER AT RATED LOAD LB. PER HR.	PASSES	TUBES	PACKING	EXPANSION JOINT OR SOLID CONNECTION TO TURBINE	CIRCULATING PUMPS				CONDENSATE PUMPS			VACUUM PUMPS		
		SQ. FT.	SQ. FT. PER KW.	INTERNAL OR EXTERNAL	SURFACE SQ. FT.						NO.	CAP. EACH G.P.M.	DRIVE	MAX. G.P.M. PER K.W.	RATIO LB. WATER PER LB. STEAM	NO.	CAP. LB. PER HOUR	DRIVE	NO.	TYPE	TOTAL CAPACITY C.F.M.
BREMO	15,000	13,000	0.867	INT.		112,220	1	7/8" O.D. X 20'-0" 18 B.W.G. ADM.	ROLLED BOTH ENDS	SPRING SUPPORT	2	14,250	290 R.P.M. 550 V. A.C. MOT.	1.9	12.7	2	1-155,000 2-158,000 3-181,000 4-197,500	VAR. SPD. A.C. MOT.	1	3 STG. JET	40 29"-70° F.
RARITAN RIVER	30,000	28,000	0.89	INT.		241,500	1	7/8" O.D. X 24'-0" 18 B.W.G.	IN. ROLLED OUT. PACKED	SPRING SUPPORT	2	23,500	245 R.P.M. 2300 V. A.C.	1.57	16.8	3	345,000	2300 V. D.C. MOT.	2	2 STG. JET	38.3
RIVERSIDE	35,000	29,000	0.83	INT.		274,108	1	7/8" O.D. X 22'-0" 18 B.W.G.	IN. ROLLED OUT. MET. P.	SOLID CONN.	2	24,500	MOT. 3 P 60 & 1 TURBINE	1.40	89.6	2	1-360,740 1-400,000	MOTOR TURBINE	1	TRIPLE 2 STG.	49 #/HR. AT 29"-80° F.W.
ASHTABULA	50,000	57,000	1.14	INT.		475,000	1	7/8" O.D. X 22'-3" 18 B.W.G.	IN. ROLLED OUT. PACKED	SPRING SUPPORT	2	1-70,000 2-68,000	1-2200 V. 250 I-DUAL DR.	2.52	1-73.7 2-132.6	2	800,000	1-2,200 V. 1200 R.P.M. IND. MOT. 1-TURB.	1	TRIPLE 2 STG.	25 AT 28" 12.5 AT 29"
HUDSON AVE.	160,000	101,000 100,000	0.631 0.625	INT. INT.	1,000	1,310,900		7/8" O.D. X 30'-0" 18 B.W.G.	PACKED BOTH ENDS	SPRING SUPPORT	2 2	73,250 72,750	▲	0.915 0.897	56 54	2 2	1,499,400	●	1 1	STM. JET	30 AT 29" 30 AT 29"
TUCO	7,500	14,000	1.87	INT.		79,200	2	7/8" O.D. X 20'-0" 18 B.W.G.	IN. ROLLED OUT. PACKED	SPRING SUPPORT	2	7,000	1501 HR 870 R.P.M. 440 V. SQ. CAG. MOTOR	1.87	88.4	2	182,500	20 HP. 1150 R.P.M. 440 V. SQ. CAGE	2	2 STG. JETS	64.8 AT 235"-70° F.
TRINIDAD	35,000	35,000	1.00	EXT.	300	299,000	1	7/8" O.D. 24'-0" 18 B.W.G.	ROLLED BOTH ENDS	EXPANSION JOINT	2	38,800	266 R.P.M. 2300 V. IND. M.	2.28	134	2	400,000	MOTOR	1	2 STG. JET	34.8 AT 1.75" & 70° F.
MOORES PARK	20,000	21,500	1.07	EXT.	12,060	194,718	2	7/8" O.D. X 21'-0" 18 B.W.G. MONTZ	METALLIC PACKING	SPRING SUPPORT	2	11,500	715 H.P. SLIP RING MOT.	1.15	57	2	250,000	A.C. MOTOR	2	STM. JET	42 AT 28" & 70° F.
LAKESIDE	60,000	55,000	0.916 (900 LB) 0.729 (TOTAL)	EXT.	1,000	394,134	1	7/8" O.D. 18 B.W.G.	ROLLED BOTH ENDS	SPRING SUPPORT	2	1-70,000 2-52,500	480 P. 277 R.P.M. IND. MOT.	1.75	13.2	2	700,000	100 H.P. MOTOR	2	3 STG. JET	20 AT 29.5"
MICHIGAN CITY	68,000	50,000	0.735	INT.	5,500	504,240	1	7/8" O.D. X 25'-0" 18 B.W.G.	ROLLED BOTH ENDS	SPRING SUPPORT	2	42,500	145 R.P.M. 2300 V. IND. MOT.	1.25	84.3	2	575,000	MOTOR	1	TWIN 3 STG. STM. JET	62 AT 29"
GLENWOOD	1-25,000 1-75,000	24,665 65,000	1.233 0.867	INT. INT.		176,140 581,250	2 2	1" O.D. 22'-0" LONG 1" O.D. 23'-0" ADM.	1 ROL. 1 PKD. RLD.-BOTH ENDS	SOLID	2 2	13,832 37,500	●	1.38 1.00	64.5 78.5	2 2	250,000 533,000	▼	4	4	22 AT 29"
P.H. GLATFELTER CO.	3,000																			
M. J. WHITTAL ASSOCIATES	1-1500 1-300	2,000 SURF. 300 JET	1.33 —	INT. —	1,110 —	DEPENDS ON EXTRACTION	SINGLE —	3/4" O.D. X 14' 18 B.W.G.	INLET EXP. OUT PACKED	EXP. JOINT	1 EA. —	2,210	CONST. SPD. MOTOR	1.4 2	—	1 —	27,500	CONSTANT SPEED MOTOR	1 EA.	SINGLE 2 STG. JET EJECTOR	12 AT 2" ABS. 70° F.
SUN BURY CONVERTING WORKS	←									NON CONDENSING										→
INDIANA BOY'S SCHOOL	100 KW. STEAM ENGINE																			
MICHIGAN LIMESTONE & CHEMICAL CO.	10,000	10,000	1.00	INT.	—	85,100	2	3/4" O.D. X 18'-0" 18 B.W.G.	IN. ROLLED OUT. PACKED	SOLID	2	1-7300 2-11,700	575 R.P.M. 440 V. IND. MOT.	1.17	72.7	2	134,900	1180 R.P.M. 440 V. IND. MOT.	1	TWIN 2 STG. STM. JET	105 LB/HR.
INDIANAPOLIS CITY HOSPITAL	←									NON CONDENSING										→
YOUNGSTOWN SHEET & TUBE CO.	18,000	23,400	1.41	INT.			2	1" O.D. X 21'-0"	IN. ROLLED OUT. METALLIC PACKING	SPRING SUPPORT	2	15,000	750 H.P. CONST. SPD. MOTOR	1.67		2		50 H.P. IND. MOTOR	1	2 STG. DOUBLE	
HAWTHORNE WESTERN ELECTRIC	2-7500	11,000	1.47	INT.	—	104,600	2	7/8" O.D. X 16' 18 B.W.G.	IN. ROLLED OUT. PACKED	EXPANSION JOINT	1 EA.	12,000	490 R.P.M. IND. MOT.	1.6	57.2	1 EA.	180,000	1750 R.P.M. IND. MOT.	1 EA.	4 NOZZLE 2 STG.	1 SET-308 E/A
KEARNY WESTERN	10,000	10,000	1.00	INT	1,295	80,000	2	3/4" O.D. X 20'-2" 18 B.W.G.	IN. FERRULE OUT PACKED	EXPANSION JOINT	2	6,250	IND. MOTOR	1.85	102.7	2	127,000	IND. MOT.	2	DBL. STG.	17.6
WORLD CLEANERS & DYERS	†																			

▲ 600/250 HP. 225/164 R.P.M. 2300 V. POLE CHANGING MOTOR 600/180 HP. 200/133 R.P.M. ■ 225/115 HP. 900/320 R.P.M. 2300 V. POLE CHANGING MOTOR 200/100 HP. 900/320 R.P.M.
● 100 HP. 575 R.P.M. 2200 V. SQ. CAGE MOTOR & 300/140 HP. 284/220 R.P.M. 2200 V. MOTOR ▼ 40 HP. 1170 R.P.M. 220 V. SQ. CAGE MOTOR & 125 HP. 870 R.P.M. 2200 V. SQ. CAGE MOTOR
2 HYDRAULIC & 2 STEAM JET. 1 EA. FOR 2 UNITS † 1 UNAFLOW & 1 COUNTERFLOW ENGINE GEN. UNIT.

Condenser auxiliaries show no radical change although there are two refinements that warrant attention. One of these is the arrangement of what amounts to two hotwell pumps in series as used at Powerton. The hotwell pump proper delivers the condensate to the suction of a booster pump which pumps against the head through the heaters. The motor is located between the two pumps, all three being on the same base plate. This is similar to the arrangement used before at Delray No. 3 and is, of course, not greatly different from the open heater arrangement at Bremo where multistage pumps are used, the various stages being in series with the open heater interposed between the discharge of one stage and the suction of the next succeeding stage.

A vacuum pump arrangement which is worthy of steam ejectors which can not be started until the high-pressure turbine is in operation.

With other plants popularity of the three-stage steam jet is increasing steadily, practically all of these units being divided into two or more sections so that the minimum number required to handle air leakage can be used and thus conserve steam. Size or capacity of the jets bear little relation to the size of the turbine unit, the air leakage being more a function of the design arrangement and construction of the equipment and piping than of the steam flow. Increased reliability of the auxiliary electrical supply system is reflected in the auxiliaries where steam drive is now a rare occurrence. Ashtabula and Riverside are the only stations in the year's list with the dual supply.

Heat Balance and Flow Diagrams

FEW MAJOR CHANGES MADE DURING THE PAST YEAR. BREMO FOR 825 DEG. AND WITH OPEN HEATERS IS THE GREATEST CHANGE. DELRAY WITH 1000 DEG. F. AND TWO MERCURY PLANTS SHOULD INFLUENCE DESIGN NEXT YEAR

IN SPITE OF THE many improvements and advances made in equipment, no major changes in heat balance or flow diagrams have been made during the past year. There are, however, many changes under way which should influence next year's designs, namely increased temperature and the mercury cycle.

Again, this year, credit for the most advanced station design must go to the Electric Management & Engineering Co. for the Bremo station design. Although following somewhat the South Amboy design with open heaters, Bremo is unique in many respects including the single-pass boilers, the use of DPO and most of all the design for 825 deg. F.

Bremo must be given credit for pioneering in the high temperature field as the first complete station designed for such operation, although the 1000 deg. F. experimental installation at Delray will undoubtedly be the most important development in the industry for many years to come. That installation, which has already been up to 1000 deg. F., is experimental and is in the hands of what is probably the most capable research and development organization in the industry. Developments there during the next year will dictate future trends. Port Washington, State Line and Sheboygan are also going to temperatures in the 800-850 range and effects of their operation should also be felt by next year.

The binary cycle using mercury vapor and steam must now be considered as a commercial venture. With the proposed installation at Schenectady and Kearny well under way, development work carried on at South Meadow station must be accorded the credit which for years was withheld. In the face of 1000-deg. steam cycles it is likely, however, that widespread recognition

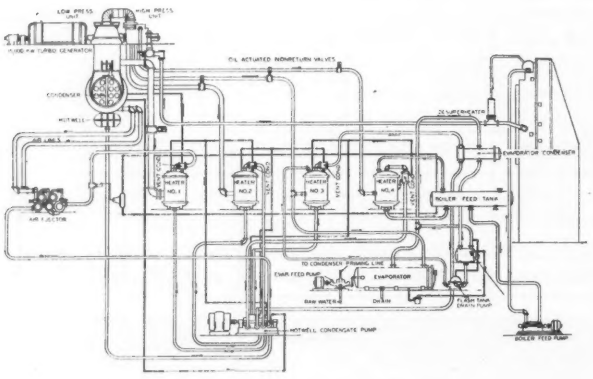


FIG. 1. BREMO STATION, VIRGINIA

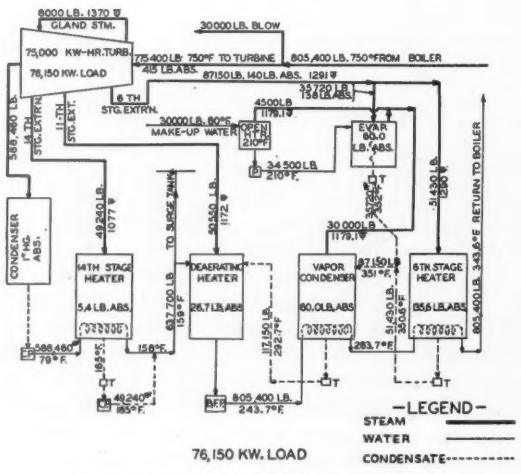


FIG. 2. GLENWOOD STATION, NEW YORK

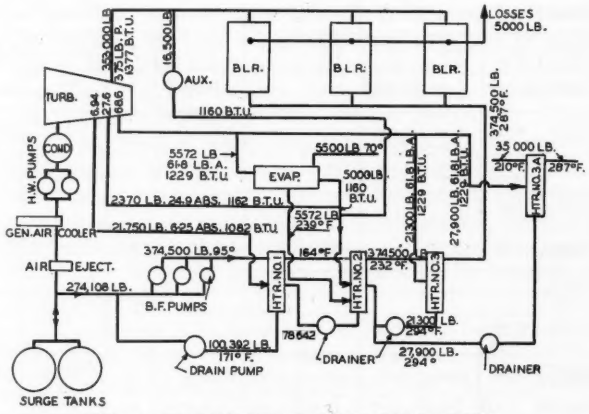


FIG. 4. RIVERSIDE STATION, MINNESOTA

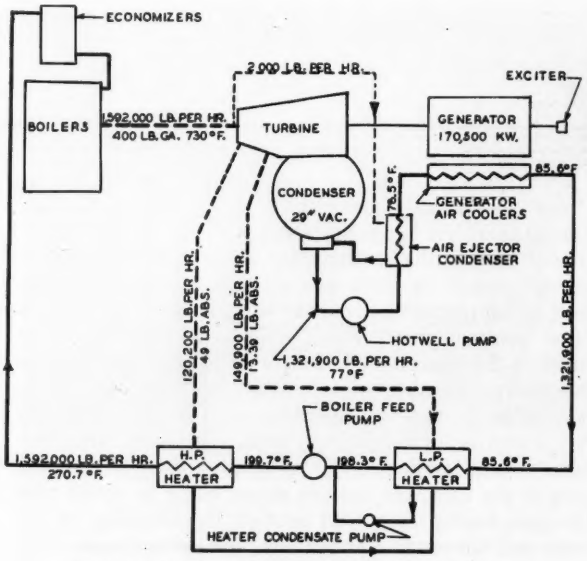


FIG. 5. HUDSON AVE. STATION, NEW YORK

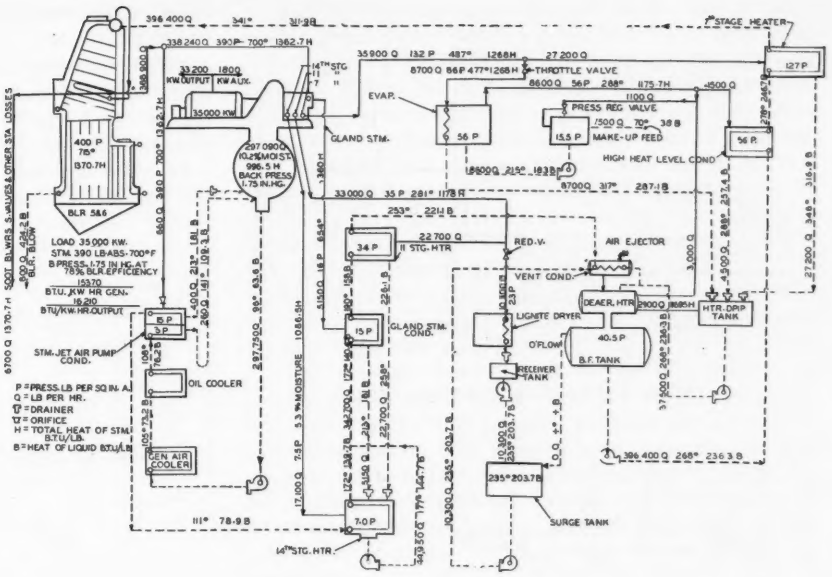


FIG. 3. TRINIDAD STATION, TEXAS

of the mercury vapor cycle will be withheld for a few more years until the economy possibilities of the higher temperatures are exhausted. Regardless of temperature limitations, the mercury plant will always have a heat economy advantage over the straight steam cycle that will some day force its adoption unless unexpected developments occur.

With the adoption of 1000-deg. F. steam, possibilities of improving the heat balance will be exhausted and we must look forward to something radically different to bring about further economies. The extraction cycle is being utilized practically up to its theoretical possibilities and further improvements in this direction can be made only by slight refinements in equipment.

There is, however, increased interest in smoke and noxious gas removal which will some day mean the removal of sulphur and carbon compounds from the stack gases. The increasing importance of solid carbon dioxide as dry ice and in industrial processes offers chance of improvement which is already being taken advantage of. Removal of these compounds requires considerable bleed steam while their liquefaction and solidification would undoubtedly be done in such a way as to fill in the valley in the night load to improve load factor and thus increase economy. Utilization of such a tremendous amount of CO_2 appears impossible but its use cannot be judged by present dry ice sales. In addition to present ice production, there is a tremendous domestic and industrial space-cooling market which has never been developed. As a manufacturer's product, such dry ice could not compete but as a byproduct made with

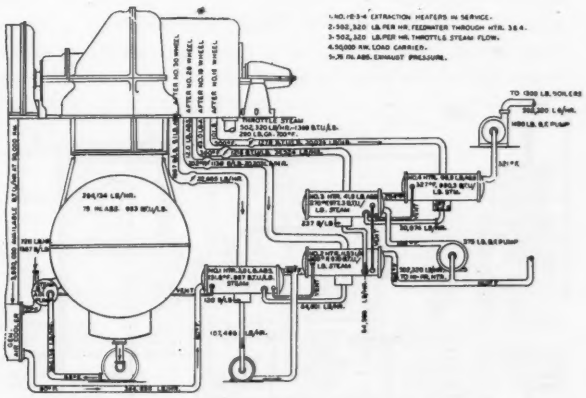


FIG. 7. LAKESIDE STATION, WISCONSIN

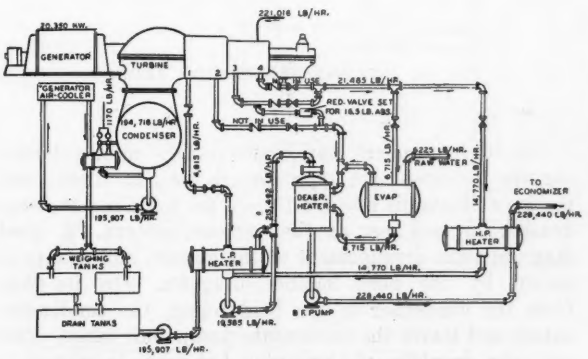


FIG. 6. MOORES PARK STATION, MICHIGAN

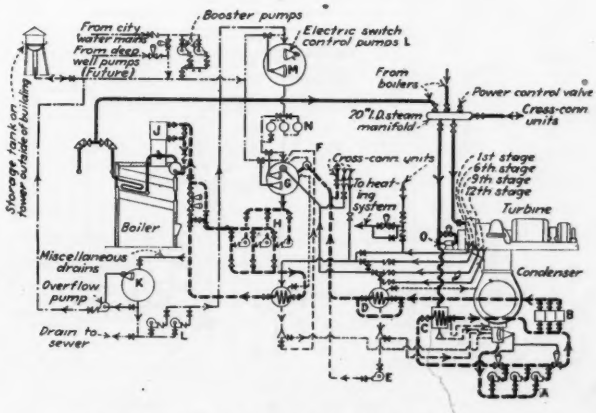


FIG. 8. RARITAN RIVER STATION, NEW JERSEY

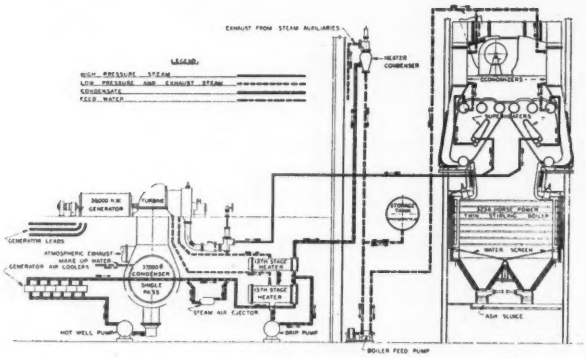


FIG. 9. ASHTABULA STATION, OHIO

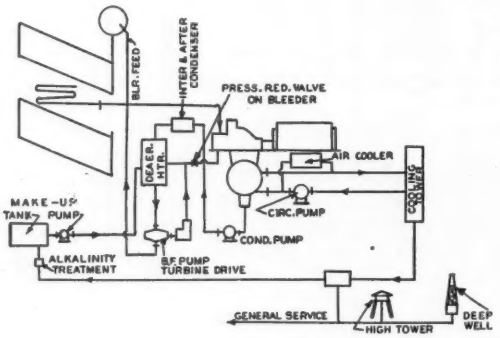


FIG. 10. TUCO STATION, TEXAS

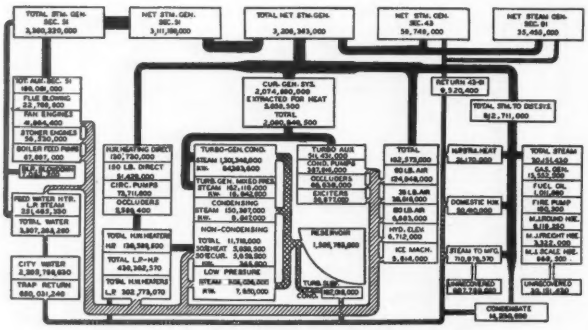


FIG. 11. HAWTHORNE PLANT, ILLINOIS

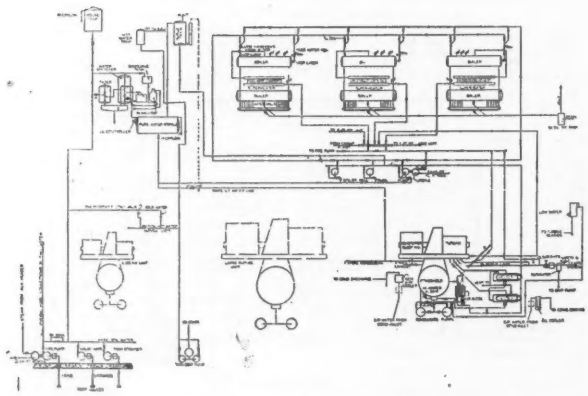


FIG. 12. MICHIGAN L & C PLANT, MICHIGAN

bleed steam and dump power, the possibilities are unlimited.

With the exception of the Youngstown Sheet & Tube Plant where industrial evaporators or heat transformers are used, the other stations represent the conventional highly developed extraction cycle. The Youngstown plant operates at a boiler pressure of 400 lb. with the boilers, turbines and evaporators in a closed cycle.

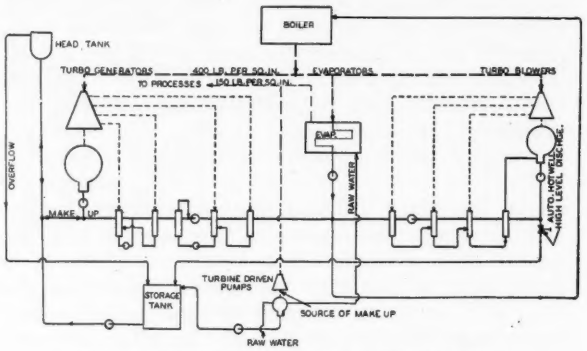


FIG. 13. YOUNGSTOWN S. & T. PLANT, OHIO

Steam requirement for the low-pressure 150-lb. industrial needs are supplied by the evaporators fed with raw river water. In its operation, this boiler plant is completely automatic, offering one of the finest examples of centralized boiler control in the country. Blast furnace gas and pulverized coal are burned in the same furnace, coal being cut in and out automatically depending upon the steam load and gas supply.

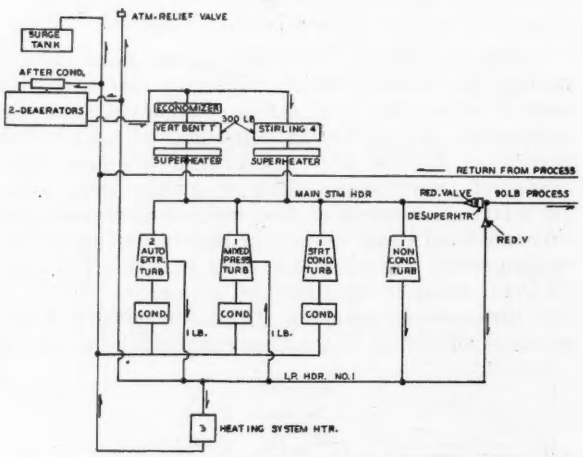


FIG. 14. KEARNY PLANT, NEW JERSEY

Of the equipment improvements, the most interesting are the open rain type heaters used at Bremo and the hotwell pumps also used there for handling the condensate in and out of the various heaters. A good diagrammatic arrangement of the heaters and pumps is shown by the heat balance diagram. On its way from the condenser to the feed pump, the condensate enters and leaves the condensate pump four times. This not only simplifies the pumping but more important it

practically removes the necessity for several complicated pump controls and prevents flooding one heater while draining the next. A storage hotwell at the condenser and a boiler feed tank at the suction of the boiler feed pumps offer storage capacity to take the small load swings. The drain from each heater exceeds the condensate flow to it by the amount of bleed steam and, with the one pump, the proportion of steam through each pump stage bears a constant relation to the next stage because they are all driven from the same shaft and motor.

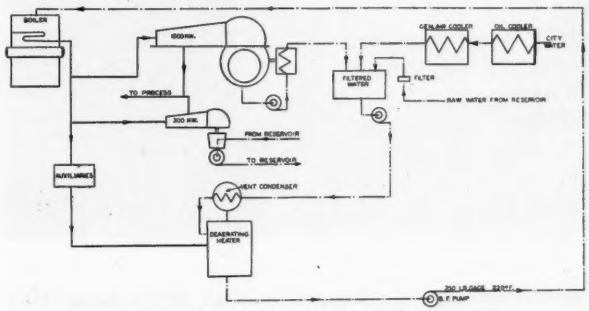


FIG. 15. WHITTAL PLANT, MASSACHUSETTS

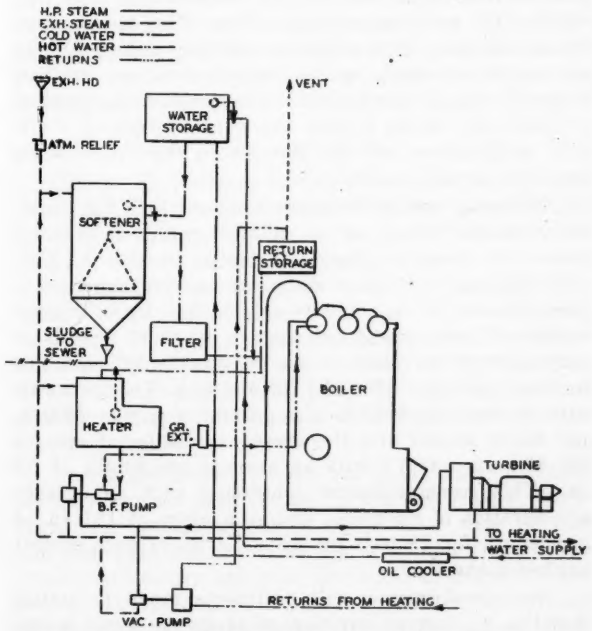


FIG. 16. INDIANAPOLIS HOSPITAL PLANT, INDIANA

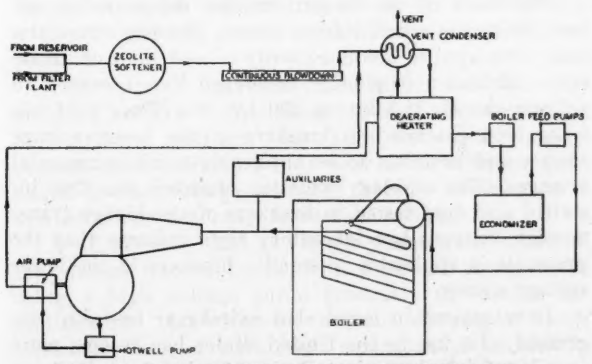


FIG. 17. GLATFELTER PLANT, PENNSYLVANIA

Again the extensive development work done at Lakeside on radiant superheaters is bound to be of increasing importance to the industry as temperatures increase bringing with it the need for closer temperature regulation. By proper proportioning of radiant and convection superheater surfaces practically any desired temperature characteristic can be obtained automatically from quarter to full load. This automatic regulation can be obtained for reheat as well as for initial superheat, both temperatures having considerable influence on the heat rate of the station at partial loads.

Results of these developments are being incorporated in the Port Washington station, an 80,000-kw. plant with one boiler and one turbine that will set a new standard of high pressure power plant design of unbelievable simplicity and stability. A tandem compound turbine with reheat in the high pressure cylinder will be used.

Central station heat balance layouts are flexible and can be made to meet the needs of local conditions, available equipment or personal opinion of the operator and the great number of layouts suggests that there is perhaps little to choose between these from an economy standpoint.

Industrial plants are, however, more limited in their choice because of process requirements and the division of electrical and steam loads. Since the complete swing toward industrial electrification, a balance between the steam and electric loads by changing drive is no longer practical. Three methods of balancing these loads are now used: First, making sufficient power to supply the steam demands and purchasing the balance; second, using a steam accumulator to balance short swings; third, by using condensers. All three methods are used successfully, a choice depending upon power rates and available condensing water.

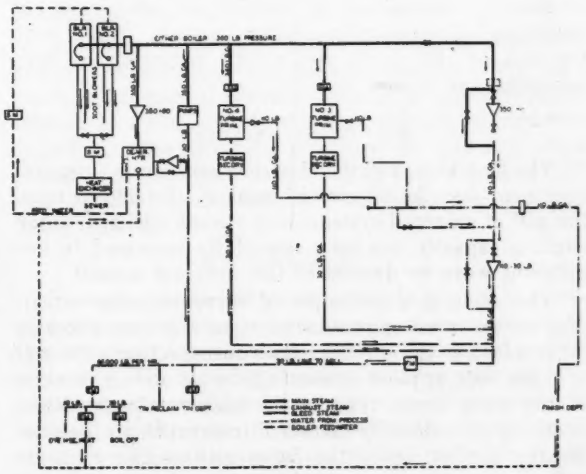


FIG. 18. SUNBURY PLANT, NEW JERSEY

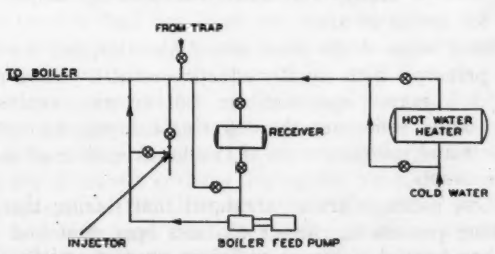
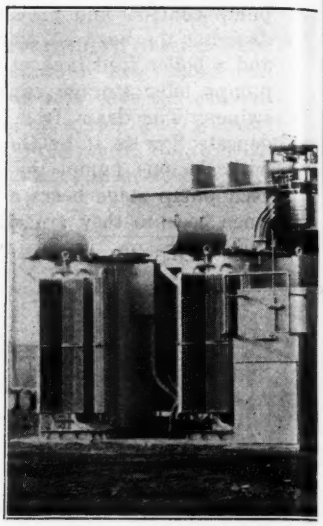


FIG. 19. WORLD CLEANERS PLANT, NEW YORK

Electric System Practice



Resume of year's progress in electric generation, transmission and distribution indicates a trend toward improvement in design so as to increase the kw. per dollar

BY GEORGE SUTHERLAND

Chairman Electrical Apparatus Committee, N. E. L. A.

MORE KILOWATTS out of the same old dollar is the 1931 theme song of the utility engineer, amplifying the slogan of more kilowatts per dollar of investment heard in engineering circles during the past two or three years. Existing equipment has been rejuvenated by the insertion of monkey glands and the operation has been successful in increasing capacity ratings. Maintenance schedules have been scrutinized and costs reduced by increasing the time between inspections after a careful analysis and classification of operating troubles. Wiring diagrams have been double checked to eliminate as many high-voltage, high-priced oil circuit breakers as might be consistent with a high standard of service continuity, determined by studies of complexity of switching balanced against outage records. Along with the rest of the world the utility engineer has been squeezing the dollar.

Oil Circuit Breakers

The first victim of the electrical apparatus surgeon's treatment was the oil circuit breaker. Unable to stand the gaff of enlarged system short circuit duties its interrupting capacity has been materially increased in two different ways by doctors of two different schools.

The deion grid principle of surreptitiously entrapping an arc in an unguarded moment and then knocking it for a loop as the current passes unsuspectingly through zero has been applied successfully to oil circuit breakers of the plain break type in the higher voltage classes, resulting in materially increased interrupting capacities. By the application of the deion grid ordinary oil circuit breakers have open 665,000 kv-a. at 110,000 v. in 1.5 cycles of arcing and 1,000,000 kv-a. at 220,000 v. with 3.5 cycles of arc.

The doctors of the other school have applied the oil-blast principle with equally effective results. They performed a major operation on the veteran explosion chamber by removing the old single break segmental contacts and inserting a set of two break spring actuated butt contacts.

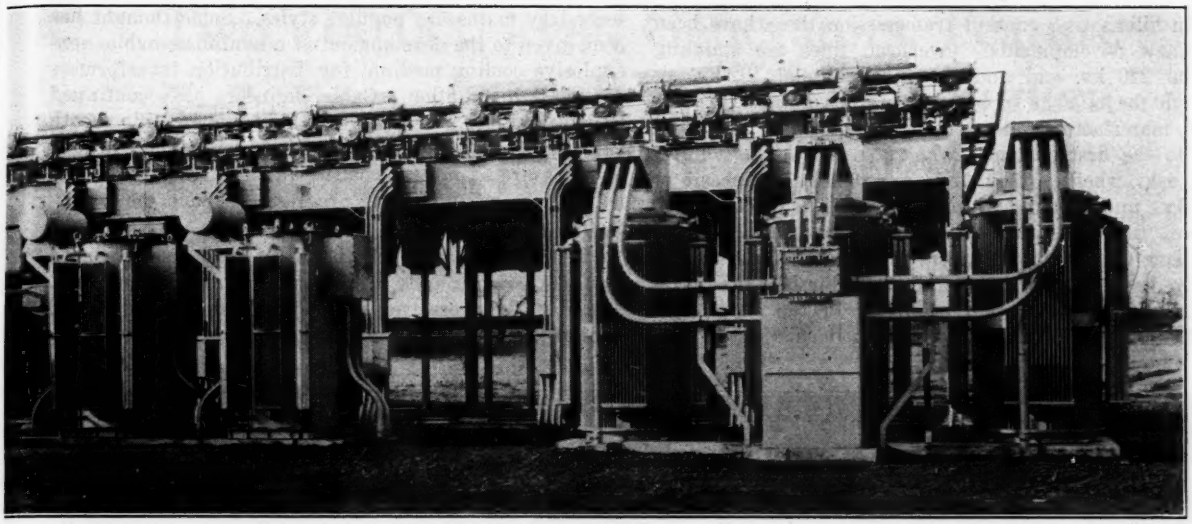
These contacts are so arranged that during the arc breaking process the upper contacts open first and the arc thus formed produces sufficient pressure within the chamber to force a volume of solid oil across the opening between the lower contacts near the throat of the explosion chamber at the time of current zero thus preventing the arc from reëstablishing. This modification in the design of the explosion chamber cuts down the arc length materially and its time of duration resulting in a reduction in mechanical stresses within the breaker, a diminution of the system effects accompanying a circuit interruption and an increase in the interrupting capacity of the breaker.

Extensive tests in the laboratory and field have demonstrated the efficacy of the oil-blast explosion chamber principle. Several papers presented at the A.I.E.E. 1931 Winter Convention described the very impressive performance of an 132-kv., 1,500,000 kv-a., circuit breaker of this type which opened 40 short circuits at varying current values on an 140 kv. transmission line up to a maximum value of 1,735,000 kv-a. The maximum rate of recovery voltage rise encountered was 2400 v. per micro second and the average duration of arc for the 40 tests was 3.5 with an average arc length of 6.8 in. This accomplishment contrasted with an average arc duration of 8.6 cycles and an average of 18.0 in. of arc length for 28 tests on the old type of butt contact explosion chamber.

Such performance will contribute much to system stability, to shorter duration of faults, to fewer industrial stoppages, and to better breaker maintenance.

The work of the circuit breaker designer has not been limited to rehabilitation alone. The new principles have been applied simultaneously to new lines of breakers. Although originally developed for breakers in voltage classes 34.5 kv. to 230 kv., the deion grid has since been extended to breakers in the lower voltage ranges and promises to be applicable to all commercial voltages. The oil-blast explosion chamber was first installed and field tested in breakers of the higher transmission voltages but laboratory tests indicate that the principle is applicable to smaller breakers in the lower voltage classes.

Development in metal clad switchgear has also progressed. Its use in the United States has become more popular, fairly large installations having been made of



switchgear in the 34.5-kv. class. Engineers have dared ask the manufacturers to discuss seriously 115-kv. applications. The schedules of Preferred Ratings for indoor and outdoor oil circuit breakers and metal clad switchgear, accepted by N.E.L.A. and A.E.I.C., have indicated faith in the future by providing ratings for metal clad switchgear in the 230-kv. and 345-kv. voltage classes.

Transformers

Oil circuit breakers having been creditably rejuvenated, the monkey-gland surgeons turned to transformers. With the application of fans to self-cooled transformer radiators already accomplished it was but a step to the circulation of transformer oil through a separate bank of especially designed fin type radiators, cooled by fans. One such installation is on record by which the capacity of an old water cooled 132-kv. bank has increased from 12,000 kv-a. to 17,000 kv-a. at a net cost of approximately $2025 per kv-a. of increased capacity, a saving of about 30 per cent.

How to get more kilowatts out of the same old dollar however, has not been the utility engineers' only worry. Lightning, switching surges and similar acts of God and man have refused to be depressed and a new surge proof transformer has been developed to resist the elements. In the design of this transformer, the proper coördination has been obtained in the insulation of winding, bushing, line and gap so that the transformer withstood test surges representing the severe conditions of a direct lightning stroke to the line close to the apparatus.

The design of the transformer is such that the surge voltage distribution throughout the high voltage winding is of uniform gradient. Insulation barriers are placed so that their surfaces are as near as possible at right angles to the voltage stresses, thereby reducing to a minimum any tendency to surface creepage.

A 42,000-kv-a., 220-kv., single-phase transformer of this design was subjected to a series of severe tests, using a high voltage surge generator to furnish the punishment. It withstood without distress a surge whose steepness of wave front corresponded to 11,000,000 v. per micro-second, which is approximately three times as steep as the steepest surge of natural lightning that has been recorded to date.

Rotating Machines

Rotating machines do not lend themselves readily to monkey-glanding so that progress this year has been in the fields of larger capacities and more interest in high voltage machines and hydrogen cooling. Two 200,000 kv-a., 60-cycle, 16,500-v. tandem compound air-cooled turbo-generators will have been installed by the end of 1931. Two 116,675-kv-a. and one 166,617-kv-a. turbo-generators have been added in the 22,000-v. class this year. One 15,000-kv-a., 24,000-v. condenser has been reported.

It is interesting to note that in England a 33,000-v. turbo-generator that has been in operation for three years was inspected recently and that no signs of deterioration as a result of its operation at high voltage were found. During its period of service, the system to which it had been connected, consisting of both overhead lines and 33,000-v. cable, had been subjected to some very heavy faults.

Rectifiers

Mercury Arc Rectifiers have been going up in capacity and troubles seem to have increased proportionately. Based on this hypothesis, a new development has been reported. The rectifier is designed on a unit basis, a large capacity rectifier being made up of a number of units all of which are of the same comparatively small capacity with transformers comparable with the capacity of the combination. Greater reliability is claimed on the assumption that the small capacity rectifier gives less trouble than the large one and reduced production costs along with other standardization advantages naturally follow the acceptance of the unit idea.

Automatic rectifier stations are gaining in popularity. Eight full automatic mercury arc rectifier stations have been installed on one of our large metropolitan rapid transit systems during the year. One station contains three 3000-kw., 625-v. rectifiers with provision for a fourth and the other seven stations house one 3000-kw. unit each.

Transmission

In alternating current transmission there have been few new developments. Overhead lines are standing pat at 220 kv. and underground cables at 132-kv. although the mileage in both classes has increased; however, manufacturers are busy planning what they will say to the first customer who steps up to the counter and asks whether they have any 330-kv. overhead or 220-kv. underground things to sell. As pointed out above, the N.E.L.A.-A.E.I.C. Preferred Ratings for Outdoor Oil Circuit Breakers include a 345-kv. rating.

In direct current transmission, the birth of the thyratron has revived the old argument of the advantages of d.c. over a.c., but all done over modernistic. Considerable research work has already been completed on the subject of high voltage direct current transmission and the conclusion is that it is feasible.

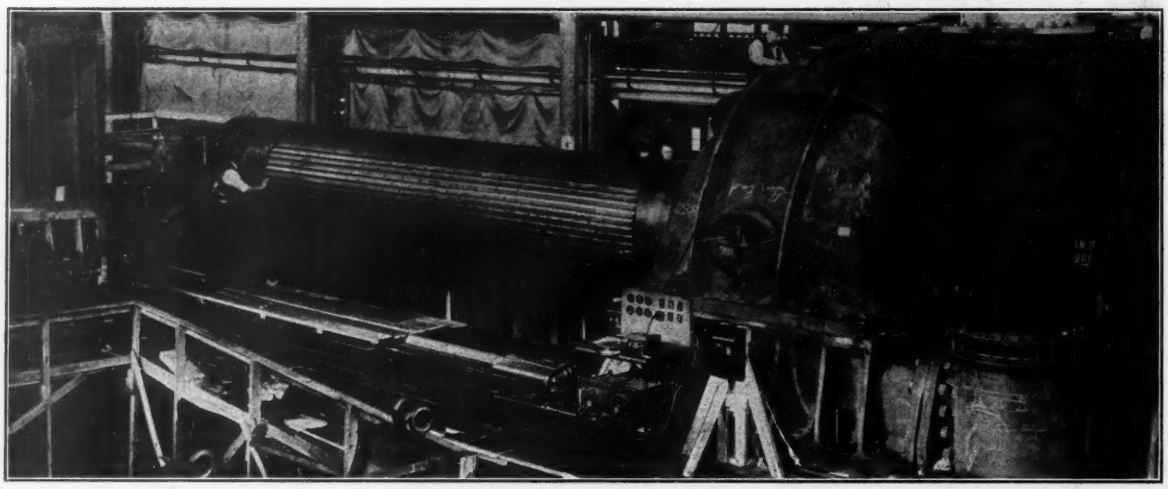
Furthermore, there may be economies in it. Even with the cost of rectifier equipment at the sending end and inverter apparatus at the receiving end, it is conservatively stated that the increase in kilowatts that could be carried over the same size line would probably more than offset the additional equipment required for the direct current transmission. For high voltage underground cable of the same copper size and the same insulation, the ratio of power transmitted is 2½ times in favor of direct current.

Other advantages in favor of direct current transmission are simplification of problems of system stability, frequency control, relative governor regulation, charging current and control of current flow.

Distribution

No startling evolutions have disturbed the calm of distribution waters during the past year but steady progress has been made in the consummation and application of previous developments. The three-phase four-wire alternating current network is increasing in favor, two more large cities having joined the a.c. network ranks since the last roll call. For large load density areas, the 500-kv-a. combination three-phase transformer and network protector unit and 500,000-circular mil secondary mains are popular styles. Some thought has been given to the development of a noninflammable, nonexplosive cooling medium for distribution transformers for vault installation. Cable engineers have continued their search for a cheaper than lead, nonmetallic sheath cable for secondary mains that would withstand overload or short circuit current heating and also accelerate burnoff, but no new types have progressed beyond the experimental stage.

The 4-kv. network, on the other hand, has advanced into the commercially available and installation stage. The manufacturers are prepared to furnish standardized equipment and a fair demand is anticipated. One installation of 1500-kv-a. units has been in operation for several months.



A REVOLVING FIELD WHICH PRODUCES 160,000 KW.
Testing the revolving field for one of the two 160,000-kw. turbine-generators for the Hudson Ave. Station at the Schenectady plant of the General Electric Co. This is the largest 1800-r.p.m. revolving field ever built, both as to size and capacity.

As in the electrical distribution field of activity, so also in the generation and transmission zones, the trend during 1931 has been towards improvements in equipment designs and applications in order to increase existing capacities and better operating conditions, thus enlarging the investment dollar and reducing the cost of maintenance. Progress has been made in getting more kilowatts out of the same old dollar.

Unemployment relief is being aided by the I-T-E Circuit Breaker Co. by an offer to donate to the fund of any community 2 per cent of the gross sales in that community for November to March inclusive, sales to be at regular prices and each order to be for $100 or more. To carry out the plan, A. Edward Newton, chairman of the board, states that $25,000 has been placed with Fidelity Philadelphia Trust Co. from which, within 10 days of receipt of an order from any locality, check will be sent to the local committee on relief in that community. Mr. Newton suggests that this or some similar plan by other manufacturers might be of substantial aid in meeting the present relief situation.

Large pulleys as possible permit the use of narrower or lighter belts.

Two 200,000 kv-a. Generators, Feature of Year's Development

ELECTRIC GENERATOR design and construction this year has progressed along definitely established lines of development, none of which, perhaps, is new but which collectively aim to make the electric generator the marvelously efficient machine it is. As pointed out by Mr. Sutherland in the preceding article, the size of generating units is still increasing; this year the limit has been extended to 200,000 kv-a. with installation of two machines of this size at Hudson Avenue. These, so far, are the largest single shaft generators ever built. They have double windings rated at 16.5 kv. and double winding auto-transformers step this voltage up to 27.6 kv.

As may be noted from the accompanying tabulation, other large machines were placed in operation at Ashtabula, Michigan City and Glenwood although in none of these stations are the machines even half as large as the two at Hudson Avenue.

The two 18,750-kv-a. units installed in the Bremo station deserve attention because they are of the largest size made in this country for operation at 3600 r.p.m. Three units of this size and speed are also installed at the Baton Rouge plant of the Louisiana Steam Products Co. An outstanding feature of these machines is the internal propeller fan used, the success of which has created a new interest in internal fans for large machines.

Test on Hydrogen Cooled Generators Encouraging

While no hydrogen-cooled generators have been placed in commercial operation, yet the satisfactory completion of tests on a 9375-kv-a. turbine-generator, cooled with hydrogen, have encouraged the serious consideration of hydrogen-cooled generators for ratings above 30,000 kv-a. A number of hydrogen-cooled synchronous condensers are in successful operation but the problem there is simpler because of the absence of revolving shafts extending through the casing. An interesting feature in connection with development of these machines is the fact that the success of hydrogen-cooled synchronous equipment depends largely upon a solution to the brush problem. It has been found that brushes operating in an atmosphere of hydrogen are subject to greatly decreased life. While this brush life can be lengthened somewhat by certain conditions of operation, it still remains an important factor of operation. An investigation was made into this matter of commutation and current collection in hydrogen by Robert M. Baker of the Westinghouse Electric and Manufacturing Co. This investigation showed that hydrogen had a deleterious effect upon the brush life but it was found that certain corrective measures could be taken which would lengthen the brush life. Among other things, the following conclusions were drawn from the tests:

1. A commutator machine designed and adjusted for good commutation in air will operate satisfactorily and give good brush life in hydrogen.
2. If a commutator machine must spark in hydrogen, the brush life may increased many times by keeping the relative humidity below 10 per cent.
3. Carbon or graphite brushes cannot be operated satisfactorily on plain tool steel slip rings running in hydrogen.

Brush Investigations

Brushes are small things compared to a 200,000-kv-a. generator and yet the operation of the generator is dependent upon them. Brush maintenance always has been an important problem in the operation of both direct current machines and synchronous alternating current machines. It is of considerable interest, therefore, to consider the results of an investigation reported this year of some of the causes of trouble that exist at the sliding contact between a brush and a rotating slip ring or commutator. It was found that when a commutator or slip ring was cut with a helical groove, many of the troubles of current collection or transmission disappeared. The results of this investigation were so convincing that when the information was given to one of the public service companies, they decided to coöperate in an experiment on the collector rings of one of their 13,000 amp. rotary converters. The operation was so satisfactory that a short time afterwards the rings on another machine were grooved. The details of this investigation were fully described in the April 15 issue of Power Plant Engineering of this year.

Generator speeds, it appears, are fairly well standardized at either 3600 or 1800 r.p.m., the higher speeds being used for the smaller sizes. It is of advantage to utilize the higher speed wherever possible and there seems to be a feeling that larger units of 3600 r.p.m. speed will be built. The 18,750-kv-a. units, as has been mentioned, are the largest units of this size so far constructed in this country but considerably larger units of 3000 r.p.m. have been in operation in Europe for some time. A turbo-alternator of 45,000 kv-a. operating at 3000 r.p.m. is in operation in Germany. There is a 31,250-kv-a., 36,000-v., 3000-r.p.m. unit at the Langerbrugge Station in Flanders, Belgium, while Poland has two 40,000-kv-a. units running at 3000 r.p.m. All of these machines are Brown-Boveri units.

Generator Voltages

Although the voltages of generators shown in the tabulation are mostly in the neighborhood of 13,000-v., there has been an attempt to use machines of higher voltages. In the case of the Hudson Avenue machines, 16,500 v. is used. From the manufacturer's standpoint, for generators of 100,000 kw. or more voltages in the neighborhood of 16,000 to 18,000 v. are reported to result in the most economical design. In some instances, economics dictates machines within this range of voltage with transformers for stepping up to the desired transmission voltage, so that, where the generator voltages are not well established, it might be said that for machines above 100,000 kw., the present trend is toward the use of multiple winding machines with transformers or auto-transformers, rather than to higher voltage machines. The trend will no doubt continue towards

multiple-winding machines until the point in capacity is reached when it will prove more economical to increase the voltage.

While, as has been said, some attempt has been made to standardize on generator voltages above 13,800-v., since the introduction of the successful multiple winding machines, the study and demand for higher standard voltage machines has not been so insistent and as reported recently by the Committee on Power Generators of the A.I.E.E., may be said to be dormant for the time being. In other words, the double winding generator has made it possible to increase the capacity without increasing the voltage and to postpone the day when it will be necessary to go to higher voltages.

It is not at all unlikely that in the future generators will be built with more than two windings. The principal difficulty with more than one winding is in finding sufficient space at the terminals of the machine to install potheads and make connections with satisfactory clearances.

A number of 22,000-v. generators are installed in this country, seven of these in the territory adjacent to Chicago having a combined generating capacity of from 52,500 to 105,000 kw. Additional 22,000-v. machines, totaling 432,000 kw. and one 18,000-v., 115,000-kw. generator are on order and will be installed in this territory during the years 1931-1932. Besides these units there have been but four steam driven generators placed on order or installed in this country for voltage ratings above 13,800 v. These are the two 16,500-v., 200,000-kv-a. machines at Hudson Avenue shown in the accompanying tabulation and two 94,000-kw., 16,500-v. units

ELECTRIC GENERATOR PRACTICE

STATION	MAIN GENERATING UNITS										HOUSE SUPPLY			
						EXCITATION			COOLING SYSTEM					
	CAPACITY KV-A.	NO. OF ELEMENTS	SPEED	VOLTAGE	VOLTAGE REGULATION	TYPE EXCITERS	CAPACITY	EMERGENCY EXCITATION	SOURCE OF COOLING WATER	TEMP. AIR IN	TEMP. AIR OUT	METHOD USED	CAPACITY	ALTERNATIVE METHOD	VOLTAGE
BREMO	2-18,750	1	3,600	13,800	AUTOMATIC	SHAFT,	85 KW. 250 V.	85 KW. 250 V. GENERATOR 125 HP. 550 V. IND. MOTOR	JAMES RIVER	89.3	85	MAIN GENERATOR THROUGH TRANSFORMER	3-400 KV-A TRANS. FOR EA. MAIN GEN	1 HSE. GENERATOR 1250 KV-A 550 V	550
RARITAN RIVER (SAYREVILLE)	2-37,500	1	1,800	13,800	AUTOMATIC	M.G. SET	175 KW. 250 V. GEN. 265 HP. 2300 V. INDUCTION MOTOR	175 KW. 250 V. GENERATOR 265 HP. 2300 V. IND. MOTOR 265 HP. TURB. DRIVEN	CONDENSATE	—	—	DIRECT CONNECT. TO MAIN UNITS	2-1875 KV-A GEN.	1-2500 KV-A. SERVICE TRANSFORMER BANKS FROM 66 KV. BUS	2300 & 440
RIVERSIDE	1-43,750	1	1,800	14,500	MANUAL	SHAFT	180 KW. MAIN 4 KW. PILOT	200 KW. TURBO GENERATOR	MISSISSIPPI RIVER	—	—	MAIN GENERATOR THROUGH TRANSFORMER	1-3000 KV-A. 3 PHASE	FROM OLD 2300 V. BUS	2300 & 230
ASHTABULA	3-62,500	1	1,800	13,800	MANUAL	SHAFT	200 KW.	300 KW. DUAL DRIVE M.G. SET	NO WATER CLOSED SYSTEM OF VENTILATION WITH GENERATOR AIR COOLER	104	—	MAIN GEN. THRO. TRANS. 1 BANK PER PAIR OF GEN. UNITS (ULTIMATE)	2-4500/7500 KV-A. OISC & WC	ESSENTIAL AUX. PROVIDED WITH DUAL STEAM-ELECTRIC DRIVES	2300 & 440
HUDSON AVE.	2-200,000	1	1,800	16,500	MANUAL	▲ SHAFT	410 KW.	2500 KW. M.G. SETS & 1-130 CELL 2000 A. HR. STORAGE BATTERY FOR ALL UNITS ▲	CONDENSATE & SEA WATER FROM EAST RIVER	65	40	TERTIARY WIND. OF GEN. AUTO-TRANSFORMER	15,000 KV-A	2-10,000 KV-A. HSE. TRANS SUPPLIED FROM MAIN HIGH TENSION BUSES (ALTERNATE SUPPLY ALSO FOR 2-137,500 KV-A UNITS	2300 & 440
TUCO	9375	1	3,600	13,200	AUTOMATIC	SHAFT	60 KW.	75 KW. M.G. SET	COOLING TWR. DEEP WELLS	105	85	MAIN GENERATOR THRU TRANSF.	3-500 KV-A.	NONE	440
TRINIDAD	1-43,750	1	1,800	12,000	MANUAL	SHAFT	175 KW.	M.G. SET	CONDENSATE OR HOUSE SERVICE	—	—	MAIN GENERATOR THROUGH UNIT TRANSF.	2-2000 KV-A TRANSF. 12 KV/2300V	FROM HIGH VOLTAGE BUS THRU 2000 KVA 60 KV/2300V. ALSO HSE. TURBO-GEN.	2300 & 220
MOORES PARK	25,000	1	1,800	13,200	MANUAL	SHAFT	100 KW.	D.C. BUS HSE CIRCUITS	GRAND RIVER	—	—	MAIN GENERATOR THROUGH TRANS.	600 & 1,000 KV-A. BANKS	1500 & 750 KV-A. HSE. TURB. GEN.	4,000
LAKESIDE	8,000	2	3,600	13,800	MANUAL	FROM EXCITATION BUS ONLY	——	EXCITATION BUS WITH BATTERY RESERVE	LAKE WATER	—	—	SECTIONS OF AUX BUS FED FROM MAIN GEN. AND MAIN STATION BUS	10-3000 KVA TRANS. 3 CONN. TO GENERATOR & 7 CONN. TO MAIN 13.8 KV. BUS	SECTIONALIZATION OF AUX BUS SECTIONS	480
	70,588	1	1,800	13,800	MANUAL	SHAFT	200 KW.	EXCITATION BUS SUPPLIED BY M.G. SETS WITH BATTERY RES.	CONDENSATE	104	—	THROUGH TRANSFORMER			
MICHIGAN CITY	1-70,800	1	1,800	22,000	AUTOMATIC	SHAFT	350 KW	NONE	LAKE MICHIGAN	● 113	● 77	AUX. GEN. & MAIN GEN. THROUGH TRANSFORMER	2 TRANS. 6000 KVA EA 1 AUX. GEN. 5714 KV-A.	ALL HSE. SUPPLY ON EITHER ONE	2300 & 400 A.C 250 D.C.
GLENWOOD	A-93,750 B-25,000	1	1,800	13,200	AUTOMATIC	SHAFT	A-265 KW. B-135 KW.	250 KW. M.G. SET	HEMPSTEAD HARBOR	140	115	MAIN BUS THRU STATION TRANS.	3-2500 KV-A 3-1250 KV-A	3000 KW. STATION GEN.	2200 & 440
P. H. GLATFELTER															
M.J. WHITTAL ASSOCIATES	1-1,875 1-375	1	3,600	600	AUTOMATIC	SHAFT	15 KW 5.5 KW.	30 KW TURBO-GEN.	STILL WATER RESERVOIR	115	75	MAIN GENERATOR DIRECT	——	NONE	600
SUNBURY CONVERTING WK	1,563	2	3,600	440	AUTOMATIC	SHAFT	16 KW.	——	——			DIRECT FROM GENERATOR		PUBLIC SERVICE	440
INDIANA BOY'S SCHOOL	1-100	1	227	220	MANUAL	——	——	——	——	—	—				
MICH LIMSTONE & CHEMICAL CO	1-12,500 1-7,500	2	3,600	13,800	AUTOMATIC	SHAFT	67.5 KW. 50 KW.	NONE	LAKE HURON	—	—	MAIN GEN. THROUGH TRANS.	3-500 KV-A TRANS.	NONE	440
INDIANAPOLIS CITY HOSPITAL	1,562	2	3,600	480	AUTOMATIC	SHAFT	13 KW	SHAFT PARALLEL OPERATION	CIRCULATING FANS CONNECTED TO DUCT TO CONTROL OUTSIDE SUPPLY	—	—	MAIN GEN. THROUGH TRANSFORMER	1-25 KV-A. DIRECT FROM BUS	480 V. FROM UTILITY THROUGH BREAKERS TO MAIN BUS	LIGHT 120-240 POWER 480
YOUNGSTOWN SHEET & TUBE CO.	2-22,500	1	1,800	6,900		SHAFT	95 KW.	M.G. SETS				MAIN GEN. DIRECT OR THROUGH TRANS.		PUBLIC SERVICE CO.	220
HAWTHORNE WESTERN ELECTRIC	2-9,375	1	3,600	12,000	AUTOMATIC	4 TURBO EXCITERS & 1-M.G. SET	5-75 KW.	75 KW. M.G. SET	RESERVOIR & F.D. COOLING TOWERS	—	—	FROM 460 V. BUS D.C. MOTOR FROM ROTARIES			440
KEARNY WESTERN ELECTRIC	1-12,500	1	3,600	13,800	AUTOMATIC	SEPARATE	2-75 KW.	75 KW. TURBO-GEN.	PASSAIC (SALT)	100	80	FROM MAIN 460 V. BUS	——	——	460
WORLD CLEANERS AND DYERS	ENGINE GEN. 1-185 ■ 1-125 COUNTER	1		240	AUTOMATIC	BELT DRIVEN	5 KW. 7.5 KW.	NONE	NONE	—	—	DIRECT FROM GENERATOR		PUBLIC SERVICE CO	240

■ 1 UNAFLOW & 1 COUNTERFLOW ENGINE GENERATING UNIT.
▲ EXCITATION NORMALLY SUPPLIED BY SHAFT EXCITERS & M.G. SETS ON EXCITATION BUS.
● 60,000 KV-A. LOAD & 26.1°F. WATER.

for the Southern California Edison Co. In Europe a number of higher voltage units are in service and their performance will be regarded with considerable interest. There are two 25,000-kw., 33,000-v., 3000-r.p.m. generators at the Brimsdown Station in England and there is the 25,000-kw., 3000-r.p.m., 36,000-v. generator at Langerbrugge, Belgium, already mentioned.

The question of voltage regulation seems to be largely a question of the type of plant. In a station supplying a nearby concentrated load by means of a number of individual feeders and where these feeders are equipped with automatic voltage regulators, generator voltage regulation is likely to be manual. In a station supplying a distant load through transmission lines, however, automatic voltage regulators will be installed. In the case of small plants such as those connected with industrial plants, automatic voltage regulation seems to be used almost exclusively.

There is little to report in regard to exciter practice that has not been said before. As shown by the tabulation, the use of the shaft exciter is practically universal. For sources of emergency excitation there seems to be no set practice, although the separate motor generator set is used in most cases, particularly where there is an outside source of supply.

In the return of questionnaires from the various stations, no mention was made regarding the use of sub-exciters and it is to be inferred that none is installed in any of the stations listed. This does not mean necessarily that the use of the sub-exciter is losing the popularity it seemed to be gaining last year. The sub-exciter is particularly useful where exceptionally quick response is desired and it may be that the types of plants included in this year's survey do not require such quick response. These sub-exciters are small exciters mounted on the same shaft as the main exciter and their purpose is to generate field current for the main exciter. The use of a special Wheatstone Bridge type of rheostat enables the exciter to operate down to zero or even reversed voltage.

As indicated in our review of developments last year, this year also shows a decrease in tendency to use a separate house turbo-generator as the main source of station power supply. More and more the station auxiliaries are supplied from the main generators through transformers. For emergency house service, however, the house generator is used in a number of plants. Where this is done, it seems to be becoming common practice to operate the house generator as a synchronous condenser under normal conditions. This, for instance, is the scheme used at the Glenwood Station where a 3750-kv-a., 2400-v., turbo-generator is installed. The turbine in this case is connected to the main condenser. A quick operating valve controlled by a frequency relay causes this machine to carry the load the instant something happens on the main electrical system. As soon as the frequency drops slightly, the frequency relay opens the valve to the turbine, causing it to pick up the load and thus maintain the voltage on the auxiliary system. Under these conditions, also, the turbine exhausts to the atmosphere—the connections to the main condenser being provided only to reduce the friction loss in the turbine casing when the machine is "spinning" as a synchronous condenser.

The whole question of auxiliary electric supply of course is closely related to that of heat balance. Originally the house turbo-generator was used in order to furnish a source of exhaust steam, for feedwater heating. With the development of the regenerative cycle and multiple extraction heaters, the need for a separate house turbine is eliminated. Where a station is connected to an outside source of power, the emergency source of auxiliary supply may as well be through transformers from the outside lines. As to voltages used, 2300 and 440 seem to be standard in most stations although in at least one station (Moores Park) 4000 v. is used.

Progress in Electric System Practice Reflected in Many Refinements

IN ATTEMPTING to indicate the development in electric system practice, one feels conscious of a great amount of development but finds difficulty in defining it. This, perhaps, is because the development has been general rather than specific. Progress this year is reflected mostly in the further refinement of equipment and in a better understanding of many of the fundamental principles involved in the transmission and distribution of electrical energy. A slight improvement here, another one there, a simpler method of doing something in another place; though each improvement may be slight in itself, taken together they constitute a real improvement of the system as a whole.

As pointed out in another article in this issue by George Sutherland, chairman of the electrical apparatus committee of the N.E.L.A., there have been few developments in a.c. transmission systems. Two hundred and twenty thousand volts still remains the highest used for transmission purposes, but there seems to be a feeling that before long this will be exceeded. Questions of system stability and interconnection problems continue to receive discussion and the problems are gradually being solved. Lightning arrester research has been given considerable attention both experimentally and theoretically and a great amount of useful data is being gathered. In these lightning investigations, the portable lightning generator and the automatic cathode ray oscillograph have been of inestimable value; indeed, without them we should know very little about the action of lightning surges on transmission lines. Lightning has ceased to be the mysterious, unamenable thing it still was only a few years ago and has become a force which, though still formidable, nevertheless conforms to the ordinary laws of electrical engineering.

Switchgear equipment has been subject to continual refinement and improvement. The deion type breaker continues to receive application and further development of this breaker both in the oil and air types is in progress. With the addition of deion grids, ordinary oil circuit breakers have opened 3500 amp. at 110,000 v.

with 1.5 cycles of arcing; and 3000 amp. at 200,000 v. with 3.5 cycles of arcing or less. Decreased arcing assures more satisfactory breaker performance, less deterioration of oil and contacts and lower maintenance.

Most interesting, perhaps, of this whole development is the work that has been done on the deion oilless breaker. At one extreme is a one million kv-a., 23-kw. circuit breaker which has undergone interrupting capacity tests including some shots as high as 800,000 kv-a. As pointed out in the recent report of the A.I.E.E. subcommittee covering this field, this performance must be compared to the achievement of a year previous, that of successfully interrupting short circuits in the order of 60,000 kv-a. On the other extreme is the breaker using 2.5-in. plates, which repeatedly interrupted 10,000

FIG. 1. METAL-CLAD SWITCHGEAR FOR STATE LINE STATION

amp. at 600 v. a.c. This small deion breaker shows great promise in a wide field of the moderate and smaller powers, such as industrial service.

The discovery of the deion principle and its subsequent application in the development of a new circuit breaker has resulted in healthy activity in the development of new forms of circuit interrupters, such as oil blast, multiple break types and others. A new oil blast breaker was announced this year which showed remarkable performance. This breaker according to those responsible for its development owes its effectiveness to the action of a scavenging blast of oil which is driven by gas pressure from an arc and which displaces the arc in the space between the electrodes of another break. The theory upon which this breaker operates was claimed to be different from that incorporated in the design of the deion. While there is still some controversy among the engineers of the respective companies responsible for the development of these two types of breakers, i.e., the deion and the oil blast types, the excellent performance of the latter cannot be questioned.

The problem of bus structure design and construction is one which is receiving a great deal of attention. The housing of major switching apparatus in both congested and open localities is being studied, particularly in new installations, because of the advent of metal clad switch gear. There has been a marked increase in the use of this type of switching equipment in place of indoor cell and outdoor open type bus structures.

Metal clad switch structures can now be obtained in practically all capacities for which circuit breakers have been developed, including 132 kv. The earlier large units involved a considerable amount of field assembly. The latest designs permit complete factory assembly and testing of very large capacity units such as a full double bus section for one circuit, complete with instrument transformers, buses, etc. These units are shipped completely assembled and oil filled, thereby entailing a minimum of field assembly and installation work and avoiding the necessity of drying out, reconditioning, etc., by the purchaser.

An equipment of this type is shown in Fig. 1. This is part of the new equipment now being installed at the State Line Station of the Chicago District Electric Generating Co. by the Westinghouse Co. Each of five units shipped recently weighs 90,000 lb. and has rating of 3000 amp. at 25,000 v. This high voltage, usually a hazard to operators is rendered safe by encasing all current carrying conductors in tubular shells filled with oil. The insulation is so effective that attendants may climb over the equipment safely even when under full potential. Compared with units of equal capacity, these oil-filled switchgear units occupy less than one third the space required by outdoor units of conventional design.

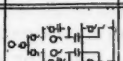
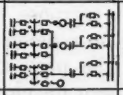
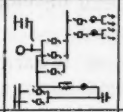
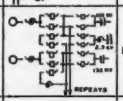
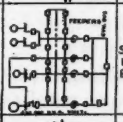
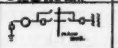
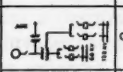
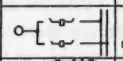
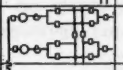
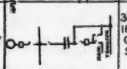
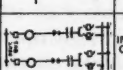
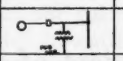
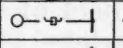
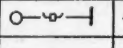
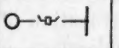
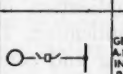
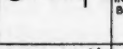
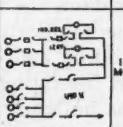
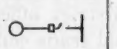
More and more there is a tendency toward the use of steel switchboard panels and the use of hinged panels or cubicles. The desirability of smaller switchboards in the larger stations is also receiving attention. Various attempts have been made to use miniature equipment and a smaller number of items, and combination units of instruments and relays. At the same time there is a growing demand for more relays and instruments for one purpose or another. Supervisory systems seem to be arousing increased interest as a means of condensing or consolidating the control of a large number of circuits within convenient reach of a single operator.

In this connection, the "control" of Bremo station is of particular interest. At this station, the entire control is centralized in one room. In the main control room which is located in the center of the station between the boiler and the turbine room, there are two benchboards facing each other. One of these controls the equipment in the boiler room and the other, the electrical equipment. The boiler room control board is of special design with a complete diagram of the piping system and with push buttons and indicating lamps for the various motor controls in their proper locations. Instruments on an inclined panel above the control board proper show the amount of air and coal going to the pulverizing mills.

Directly opposite this combustion control board is the main electrical control board. This is of standard construction using the new miniature type instruments. An interesting features of this board, however, is the control knobs. These are made in various shapes so that the operator may know from the "feel" of a switch just what type of switch it is. A further safety feature is incorporated in the design of these control knobs by equipping them with Yale locks. To close a switch the operator first has to obtain the correct key for that switch from a rack and insert it into the proper control knob.

This "control" at Bremo is described in some detail here because to our knowledge it marks the first entire centralized control installation in a central station in this country. As has been stated, the control room is in the center of the station, on the same level as the

ELECTRIC SYSTEM DATA

STATION	BUS AND SWITCHING SYSTEM: SINGLE LINE DIAGRAM GENERATOR TO BUS	BUS AND SWITCHING SYSTEM: TYPE & VOLTAGE OF OIL CIRCUIT BREAKER	BUS SYSTEM: TYPE	BUS SYSTEM: VOLTAGE	PROTECTIVE: REACTORS	PROTECTIVE: RELAYS	PROTECTIVE: GROUND	PROTECTIVE: TYPE LIGHTNING ARRESTOR	TRANSFORMERS: TYPE	TRANSFORMERS: PURPOSE	TRANSFORMERS: CAPACITY	TRANSFORMERS: WINDING CONNECTION	TRANSFORMERS: POTENTIAL CHANGE
BREMO		138 KV. OUTDOOR MOTOR OPER.	OUTDOOR BUS	PRESENT 66 KV. FUTURE 115 KV.	NONE	GENERATOR AND TRANS. DIFFERENTIAL	THROUGH REACT. MAIN & STATION TRANS. NOT GROUNDED	THYRITE	O.I.S.C. O.I.S.C. O.I.S.C.	MAIN PWR STA. SERVICE GROUND & LOCAL USE	3 - 6250 3 - 400 3 - 500	Δ/Δ Δ/Δ Y/Δ	13.2/66 KV. 13.2/.55 KV. 66/6.6 KV
RARITAN RIVER		73 KV. OUTDOOR SOLENOID OPER.	OUTDOOR BUS ONLY	69 KV.	NONE	GENERATOR AND TRANS. DIFFERENTIAL	GENERATOR NOT GROUNDED - MAIN TRANS. SOLIDLY GROUNDED	AUTO-VALVE	O.I.S.C. O.I.S.C. O.I.S.C.	MAIN PWR. AUX. BANK AUX. BANK	3 - 12 500 3 - 833 6 - 150	Δ/Y Y/Δ Δ/Δ	13.8/69 KV. 69/2.3 KV 2300/460 V.
RIVERSIDE		15 KV. INDOOR SOLENOID OPER.	VERTICAL ON STEEL FRAMEWORK	14.5 KV.	15 KV. IN ALL FEEDERS & CONNECTION TO OLD 13.2 KV. BUS	GENERATOR AND TRANS. DIFFERENTIAL	GEN. NOT GRDED. SYSTEM GRNDED THROUGH GROUNDING TRANSFORMERS	NONE ALL FEEDERS UNDERGROUND	O.I.S.C.	REGULATION BETWEEN NEW & OLD BUSES	1 - 45,000 KV-A. 3 ϕ		
ASHTABULA		15 KV. 1 PER POLE	VERTICAL ISOLATED PHASE	13.8 KV.	GEN. LEADS BETWEEN MAIN & SYN. BUSES HSE. TRANS. LEADS BETWEEN EVERY 2 GEN. IN TRANS & SYN. BUSES	GENERATOR DIFF. TRANS. OVERLOAD RELAYS	GEN. TIE TO NEUTRAL BUS WHICH IS GRD. THROUGH 30 OHM RESISTOR	NONE INDOOR OXIDE FILM ON 132 KV. CIRCUIT	O.I.S.C. NON RESONATING	MAIN POWER	9-20,000	Δ Y	13.2/138 KV.
HUDSON AVE.		27 KV. INDOOR SOL. OPER. VERT. ISOLATED PHASE ELEVATING TYPE	VERTICAL ISOLATED PHASE MODIFIED STAR BUS	27 KV.	27 KV. IN ALL FEEDERS AND CONNECTIONS TO SYN. BUS	GEN. & TRANS. DIFF. DIFFERENTIAL & OVERLOAD ON FEEDERS & FEEDER GROUP BUSES	GEN. & TRANS. SOLIDLY GRD.	NONE ALL FEEDERS UNDERGROUND	RADIATOR TYPE 1 ϕ AUTO. TRANS. WITH TERTIARY WINDINGS	MAIN AND AUX. PWR.	3-66,667 KVA FOR EA. UNIT ▲		16.5/27.5 KV. & 2,300 V. TERT.
TUCO		15 KV. OUTDOOR SOLENOID OPER.	HORIZONTAL ISOLATED OUTDOOR	13.2 KV.	NONE	GEN. & TRANS. DIFF. ALSO TRANS. OVERCURRENT PROTECTION	GEN. GROUNDED TRANS. NOT GROUNDED	OUTDOOR BUS ARRESTER INDOOR GEN. ARRESTER	O.I.S.C.	MAIN POWER	3-3,333 KVA	Δ Δ	13.2/28.4 KV.
TRINIDAD		OUTDOOR TYPE	CUBICAL SYS.	60 KV. 132 KV.	NONE	GENERATOR DIFF. TRANSFORMERS O'CURRENT.	GEN. GROUNDED THRU. NON-AUTO O.C.B. TRANS. SOLIDLY GROUNDED	NONE	O.I.W.C.	MAIN POWER	3-15,000 KVA	Δ-Y AUTO.	12/60/132 KV.
MOORES PARK		13.2 KV. INDOOR MOTOR OPERATED	DOUBLE	13.2 KV.	IN BUS SECTION ONLY	GENERATOR DIFF.	1 GEN. NEUTRAL	NONE ALL FEEDERS UNDERGROUND	NO MAIN POWER TRANS.	TRANSMISSION AT 13.2 KV. & 4 KV.			
LAKESIDE		15 KV. SOLENOID OPERATED	HORIZONTAL ISOLATED PHASE	13.8 KV.	13.8 KV. IN ALL FEEDERS ISET BUS REACT.	GEN. DIFF. TRANS. DIFFERENTIAL O'LOAD FAULT BUS & GRD. PROTECTION	GEN. NEUTRAL THROUGH 3 OHM 27.6 & 132 KV. TRANS. NEUT. GRD. SOLIDLY	OXIDE FILM ON OVERHEAD FEEDERS	O.I.S.C.	MAIN POWER	6-10000 KV-A IN 27.6 KV. 18 TOTAL LINE 240,000 KV-A IN 132 KV.	Y A Δ Y	13.8/27.6 KV. 13.8/132 KV.
MICHIGAN CITY		37 KV. SOL. OR OCDOR 182 KV. MOT. & SOL. OUTDOOR - 3.5 KV. SOLENOID OPER. METAL CLAD	22 KV OUTDOOR COPPER TUBING	OPEN 132 KV. METAL CLAD 2.3 KV.	1 IN GEN. NEUTRAL	GEN. DIFFERENTIAL & O'LOAD TRANS. DIFF. & OVERLOAD FEEDERS DIRECTIONAL IMPEDANCE & GROUND FAULT	GEN. THRU. REACT. & OC.B. TRANS. SOLIDLY GRD. NEUTRAL ON 132 KV. SIDE	33 KV. & 132 KV. FEEDERS OXIDE FILM	O.I.S.C. O.I.W.C.	MAIN POWER HSE. POWER LIGHTING EMERGENCY FEED	4-25,000 KV-A 2-8,000 KV-A 4-5 000 KVA MAIN POWER	Δ-Y AND Y-Y	22/132 KV. 2.3/22 KV. 440/2300 V. 2300/4000 V. 33/13.3/132 KV.
GLENWOOD		INDOOR 15 KV. 7.5 KV. OUTDOOR 73 KV.	OUTDOOR	66 KV.	IN 2300 V. AUX. BUS ONLY	GEN. DIFFERENTIAL TRANS. DIFFERENTIAL	GEN. THRU. 4 OHM 66 KV. BUS THRU ZIG-ZAG TRANS	OXIDE FILM	O.A.P. O.I.S.C.	MAIN POWER & AUX.	MAIN PWR. 4-833 4-31,250 3-3333 3-2,500 3-1,250	Δ-Y Δ-Δ	13.2/66 KV.
P.H. GLATFELTER CO.													
M. J. WHITTAL ASSOCIATES		4.5 KV. MANUAL	OPEN COPPER BAR	.6 KV.	NONE	NONE ON GEN.	GEN. NOT GROUNDED	NONE	O.I.S.C.	STEPPED UP TO DISTANT MILL 2.3 KV.	3-125 KV-A.	Δ-Δ	2.3/.6 KV.
SUNBURY CONVERTING WORKS		4.5 KV. MANUAL	3 ϕ HORIZ.	.44 KV.									
INDIANA BOYS' SCHOOL													
MICHIGAN LIMESTONE & CHEMICAL CO.		15 KV. INDOOR SOL. OPER.	HORIZ. ISOLATED PHASE	13.8 KV.		GEN. DIFFERENTIAL RELAYS	GEN. GRD. NEUTRAL	OXIDE FILM					
INDIANAPOLIS CITY HOSPITAL		GEN. BKR. .6 KV. 1500 A. FDR. BKR. 4.5 KV. OCB INTERLOCKING - BKR 4-5 KV. 400 A.	MAIN & EMERGENCY BUS	.48 KV. 3 ϕ 60~	NONE	2 O'CURRENT S.P. PLUNGER TYPE RELAYS IN EA. FDR. CIRCUIT TO EACH BLDG.	48 KV. 3 ϕ 60~ FDR. SYS. UNGRD. 12-208 KV. 3 ϕ 60~ 4 WIRE GRD. SEC.	NO OVERHEAD LINES. NONE REQUIRED	O.I.S.C.	EMERG'CY & MAIN L&P ALL POWER SIZ & ABOVE 460 V.	SIZE 7.5 - 10 - 15 25 - 37.5 NO. OF EA. 1-1-8-11-3 RESPECTIVELY	Δ PRIMARY Y SECONDARY WITH NEUTRL TAP FOR 3 ϕ 4 WIRE	EMERGENCY 480 - 120/240 1 ϕ 3 WIRE GEN. - LIGHT. 480 - 120/208 3 ϕ 4 WIRE
YOUNGSTOWN SHEET & TUBE CO.		66 KV. INDOOR	3 ϕ GROUP	6.6 KV.	NONE	GEN. DIFFERENTIAL SHORT CIRCUIT RELAYS ON BUS. TRANS. DIFF.	← NO DATA SUBMITTED →						
HAWTHORNE WESTERN ELECTRIC		15 KV. INDOOR MOT. & SOL. OPER METAL CLAD	MAIN	12 KV.	NONE	GEN. DIFFERENTIAL & TRANS. DIFFERENTIAL PROTECTION	GEN. GRD.	NONE	O.W.C.	TIE BETWEEN 12 KV. & 46 KV. BUSES	2-3,000 KV-A 3 ϕ	Y-Δ	12/46 KV.
KEARNY WESTERN ELECTRIC		460 V. A.C.B. SOL. OP. 13.8 KV. 15 KV. O.C.B. SOL. OPER.	460 V. BUS BAR ON 15" CENTRS. OPEN METAL CLAD	460 V. 13.8 KV.	IN NEUT. ONLY ON 13.8 KV. SYS. IN EA. PHASE OF 460 V. FDRS.	13.8 KV. GEN & TRANS. DIFF. PROTECTION. IND. TYPE OVERLOAD FOR 13.8 KV. FDRS. R.Q. TYPE O.L. ON 460 V. FDRS NO PROTECTION ON 460 V. GEN	GENERATOR & TRANSFORMER GRD. THRU 4-REAC 460 V. SYS. GRD. BY AUTO-TRANS & GEN. NEUTRAL SOLID TO GRD.	NONE OUTDOOR METAL CLAD SWITCH GEAR & UNDERGROUND CABLE	O.I.S.C.	MAIN POWER	2-3,000 KVA 6-1,000 KVA	Δ-Y Y-Δ	460/13,800 V. 13,800/460 V
WORLD CLEANERS & DYERS													

▲ MAIN POWER RATING ONLY

turbine room floor. No dividing walls separate this room from the boiler and turbine rooms; on one side the operator's vision is over the electrical board into the turbine room while on the other, over the boiler control board, he looks out into the boiler room. Both major divisions of the plant, therefore, are under his direct observation and he is instantly aware of any unusual occurrence.

In all the other stations covered in this year's survey, the control of boiler and turbine room is separated, as has heretofore been the practice. This does not mean that the centralized control feature in Bremo station is exceptional and that it will not become general practice. Most of the installations this year were additions to existing stations and the control for such installations, naturally, followed the design of that used in the initial installations. In new stations, however, there seems to be no valid reason why the control should not be centralized and we look for further applications of this idea.

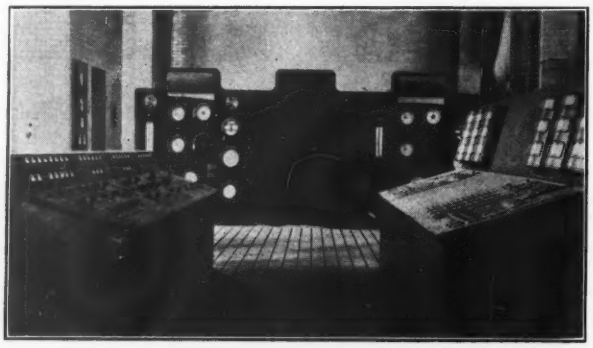


FIG. 2. THE CENTRAL CONTROL ROOM AT BREMO STATION

Protection of Circuits and Equipment

Practice in protecting generators seems to have been quite definitely standardized upon the differential relay system of protection, for as will be noted from the tabulation, every large machine listed is provided with that type. This system of protection has proved its worth for it keeps the generator on the line under all conditions except only that of internal failure. Transformers too are being provided with differential protection, although, here, in many cases overload protection is also provided. In the case of large transformers, it is common practice not to provide automatic protection for over currents but to depend upon the operator to correct such conditions when warned by indicating instruments.

In other fields, relay protection has received considerable development. Further development of high voltage transmission and interconnection with rather severe requirements as to stability and continuity of service have made it necessary to provide means for rapid clearing and with extreme precision; as a consequence the art of relay protection has developed. Relays have been developed including directional, balanced and differential, capable of operating in one sixtieth of a second. These are being tried out in service and their operation is being watched with much interest.

For protection against lightning, the Oxide film Auto-valve and Thyrite arresters seem to be in greatest favor. The new autovalve arrester employing porous blocks is considerably smaller and has better performance characteristics than the old. The protective action of the new arrester is similar to the old one but it has practically no time lag in its operation and a low ratio of discharge voltage to normal voltage. A small but compact form of line arrester has been developed which can be applied to prevent flashover of insulator strings. Also a similar Thyrite arrester for this purpose.

A new protective device operating on a deion principle in a small hose tube for use in the prevention of insulator flashover by lightning has been developed.

Transformer Practice

Transformer developments have been toward larger and more compact units, and towards more effective protection against lightning surges. As explained in the article by George Sutherland in this issue, the idea now is to design transformers so that the surge voltage distribution throughout the high voltage winding is of uniform gradient. Transformers of this type have stood full voltage flashover tests remarkably well.

Further studies of transient voltage phenomena within auto transformer windings have resulted in the development of the nonresonating auto-transformer. Several such units have been built for 230-kv. service.

In the field of transformer accessories, a feature of interest this year was a new type of transformer radiator developed to replace the tubular type on all Westinghouse large self-cooled power transformers. All of its joints are formed with the edge welds on the outside of the radiator and there are no crevices or flat surfaces where water can accumulate.

Another interesting development, by the Brown Boveri Co., was a new no-load ratio adjuster which is operated through the side of the tank wall instead of the cover, making it more convenient to operate and permitting the top position to be safely checked without deënergizing the transformer.

House Insulation Is Subject of New Commerce Booklet

Authorities on building and housing, headed by LeRoy E. Kern of Washington, D. C., representing the American Institute of Architects, have coöperated with the National Committee on Wood Utilization of the Department of Commerce in the publication of House Insulation: Its Economies and Application, the Committee's latest report in the building and construction field.

The bulletin outlines the history and uses of insulating materials in man's struggle to keep himself warm in winter and cool in summer. It explains the manufacture of wood fibre insulation and the application of all types of insulating materials in building and construction. Approximate cost tables for insulating various types of houses are a feature of the bulletin.

The bulletin was written by Russell E. Backstrom, insulation specialist of the wood utilization committee's staff. It is fully and attractively illustrated and nontechnical in its treatment of the subject. The bulletin contains 52 pages. It may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., or from the district offices of the Department of Commerce in principal trade centers. The price is 10 cents a single copy.

Progress in the Diesel Engine Field During 1931

IMPROVEMENTS IN DESIGN AND CONSTRUCTION, ENGINES UP TO 4000 HP. INSTALLED AND SOME OF 7000 HP. UNDER CONSTRUCTION, COMPLETELY AUTOMATIC DIESEL PLANT, BUTANE ENGINES, HIGH SPEED AUTOMATIC AND AIRPLANE DIESELS ARE AMONG THE DEVELOPMENTS

PROGRESS in the Diesel engine field during the past year has for the most part taken the form of consolidation of ground already gained and of further developments along the lines indicated in Power Plant Engineering's review of December 15, 1930. The accompanying table shows a number of typical Diesel engine installations made during 1931. In many cases the engines noted here are additions to existing plants.

Of the general trends in construction to which attention was called in last year's review number, several of these have been rapidly developing in importance during the last few years. The possibility of employing improved metals such as chrome nickel steel for crank shafts, chrome molybdenum steel and other alloys for various other parts has been reflected in engine design. For preventing corrosion from various sources, chromium plating, nitriding and stainless steels have been used. Chrome nickel or nickel cast iron for cylinders, aluminum alloys for pistons, better forgings for crankshaft, are among the items on which further progress has been made. Precision methods of manufacture have led to improved construction and lower maintenance.

Fuel Oil Consumption

Engine data on the attached table show some of the general tendencies in operating practice in a number of plants obtaining Diesel engines installed during 1913. Fuel consumption figures for these engines range from 9.0 kw-hr. per gal. of fuel oil to 13.45 kw-hr. per gal. average for an entire plant. The two values just noted are the low and high extremes respectively. Most of the figures for fuel consumption are between 10.5 and 11.6 kw-hr. per gal. with one station reporting 12.5.

There is no such uniformity as this in lubricating oil consumption figures and the wide variation in these figures shown on the accompanying table makes it impossible to draw any general conclusion.

The table shows also the attention that is being paid to the purification of lubricating oils, as most of the plants noted here have centrifugal methods for purifying. Purification of fuel oil is also receiving considerable attention.

Best Diesel engine practice demands considerable attention to water treatment and filtration of air for the engine. Most of the plants noted have some provision for filtering the incoming air, while a number of them treat the cooling water in various ways. It has become common practice to require analysis of cooling water supplied for Diesel engines, to determine whether water treatment is necessary or not.

Large Diesel Engines Installed

In any review of the year's progress, some discussion of the largest Diesel units produced during that period is always of interest. The largest single unit so far projected is the double-acting, two-cycle engine of 18,500 b.hp. capacity, with an overload capacity of 22,500 b.hp., designed for installation at Copenhagen, Denmark.

The largest engines now planned for installation in the United States are the 7000-b.hp. units now under construction for the City of Vernon, California. According to recent announcement, five of these units are to be installed, giving the plant a total initial capacity of 35,000 hp., which will make it the largest municipal Diesel plant in the country. These units are of the double-acting, two-cycle type, operating on the solid injection principle. They run at 167 r.p.m. and are directly connected to 5000-kw., 7200-v., 50-cycle, 3-phase generators. Scavenging air for the engines will be furnished by independent motor-driven turbo-blowers. These units will have 8 cylinders each, the cylinder size being 24 by 36 in.

Other large engines installed or projected during the year that have attracted considerable attention include a 4000-hp. 6-cylinder engine for the Tucson Gas & Electric Co., Tucson, Ariz.; a 3000-hp. engine for the Sterling, Colorado plant of the Public Service Co. of Colorado, and a 3000-hp. engine for the Village of Freeport, N. Y.

The Completely Automatic Diesel Plant

Among the year's developments was the placing in operation of a completely automatic Diesel engine installation in the Hotel Chelsea, New York. This installation consists of three 75-hp. Diesel generating units, the generators rated at 50 kw. each; a 240-v. storage battery, a battery booster, a 240 to 120-v. balancer and an automatic switchboard, all contained in an interior basement room. Starting and stopping are controlled by adjustable load relays normally set to keep the load on these engines between 40 and 90 per cent of rating. Loads less than 20 kw. are carried by the storage battery and when the load increases beyond this amount, or when the battery has discharged to a predetermined point, the first unit is started by motorizing its generator with current from the battery. The engine immediately takes over the entire load and also recharges the battery. The first engine carries the load up to 45 kw. when the second is started by its load relay and divides the load with the other so that each runs at 45 per cent of rating. The two units serve the load until it increases to 90 kw. when the third goes on, reducing the load per unit to 30 kw. or 60 per cent of rating. Load increases during the engine's starting periods are carried by the battery.

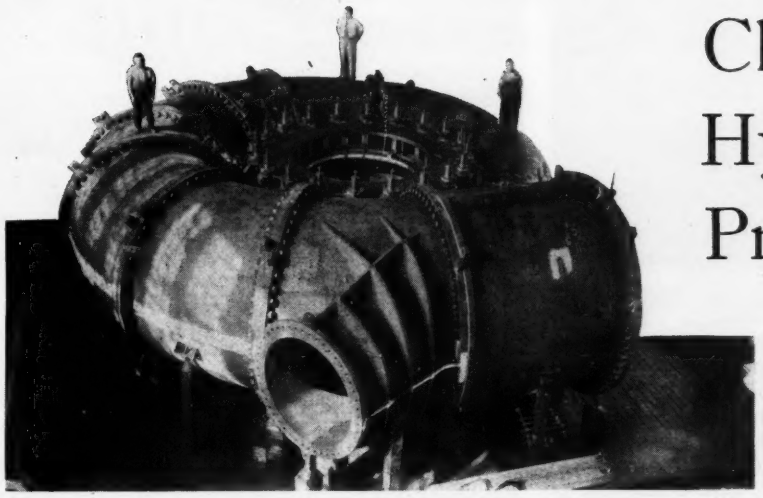
If supply of fuel or lubricating oil should fail, the engine fuel pumps are shut off by automatic control devices, the engine is disconnected from the bus and another unit is immediately put into service. Meanwhile the full power service is maintained by the running engines supplemented by the storage battery. The latter has sufficient capacity to carry the entire load for a short time. Automatic devices are also provided to disconnect the engine if it should fail to start when required.

DIESEL PLANT DATA

PLANT	LOCATION	KIND OF SERVICE	ANNUAL NET STATION OUTPUT KW HR	AVERAGE NET STATION OUTPUT KW DAILY	CORRESPONDING DAILY HOUSE LOAD	PEAK LOAD KW	LOAD FACTOR		HP OF UNITS	NO CYLINDERS	CYCLE	FUEL INJECTION	CYLINDER AIR COMPRESSOR	FUEL		OIL CONSUMPTION KW. HR. PER GAL		TYPE OIL PURIFICATION		FUEL OIL STORAGE		COOLING WATER					WATER TREATMENT		AIR FILTER TYPE	EXHAUST		
							PLANT ②	MACH. ③						BAUME' GRAVITY	B.T.U. PER GAL.	FUEL	LUBRICANT	FUEL	LUBRICANT	TYPE AND LOCATION	CAPACITY GALLONS	METHOD	TYPE SYSTEM	TEMP. °F. IN	TEMP. °F. OUT	STORAGE CAP. GAL.	TYPE	CAP. GAL. PER DAY		TEMP. °F. ④	TYPE COOLING	TYPE MUFFLER
SASKATCHEWAN POWER COMM	SWIFT CURRENT SAS.	P & L 24 HR SERV.	2 295,000	8,500	350	700	——	——	2-600 1-1250 †	600-6 600A 1250-4	4 2	AIR	PISTON	——	——	13.45 AVE 1250 UNIT ABOUT 13.0	——	NONE	CENTRIF.	ABOVE GRD.	30,000	TOWER	CLOSED	50	110	8,300	ZEOLITE	500	MULTI-CELL FOR 1250 HP. UNIT	750 AVE	MANIFOLD	SOUND WAVE FILTER
PUBLIC SERVICE CO OF COLORADO	STERLING COL.	BASE LOAD CENT STA.	7,000,000	800 KW	300	2200	——	——	1-3,000 † ▼	10	2	SOLID	BLOWER	26-30	145,000	——	——	CENTRIF	CENTRIF	UNDER GRD.	25,000	TOWER	CLOSED	——	——	4,800 Δ	CHEMICAL	——	MULTI-CELL	——	MANIFOLD	BAFFLE CYL. TYPE
HOTEL CHELSEA ■	HOTEL CHELSEA NEW YORK CITY	COMPLETE POWER SERVICE	450,000	1230	51	125	0.41	0.65 ■	3-75	4	2	SOLID	ROT. VANE PUMP	33	140,000	10.66	583	FILTER	COAGULATING RELLAIMER	CELLAR TANK	1500	CITY	OPEN	50	125	10,000	NONE	——	NONE	300-400	NONE	EXP. CHAMBERS
RUSSELL, BIRDSALL & WARD BOLT & NUT CO.	ROCK FALLS IA.	MAIN IND POWER	2,000,000 EST	7000	——	——	——	——	1-1,000 5-375	883	4	AIR	PISTON 3 STG.	22-26	148,000	10.0	——	NONE	CENTRIF	ABOVE GRD.	300,000	RIVER WATER	OPEN	50	125	——	NONE	——	MULTI-CELL	700	MANIFOLD	SOUND WAVE FILTER
MUNICIPAL LIGHT & WATER	FREEPORT N.Y.	L & P	7958 000	21 780	2660	2985	0.31	—— ▲	1-380 2-750 2-1150 1-1500	4 4 6 6	4 2 2 2	AIR	PISTON 3 STG.	28-32	138 750	11.8	3 380	FILTERS □	CENTRIF	UNDER GRD. ABOVE GRD.	18,000 40,000	TOWER	OPEN	60	130	22,500	TREATED FOR pH	13,000	MULTI-CELL	550	MANIFOLD	POT MUFFLER & SOUND WAVE FILTER
ELECTRIC LIGHT & WATER WORKS PLANT	OPELOUSAS LA.	L & P	2,840,000	7,333	—	620	0.930	0.40	2-250 1-600 1-960 †	4 6 6	4 4 2	AIR	PISTON	28-30	114,000	12.5	2,400	NONE	CENTRIF.	UNDER GRD	25,000	CONN. DIRECT TO MAIN		75	110	——	NONE	——	MULTI-CELL	680	MANIFOLD	SOUND WAVE FILTER
LOGAN CITY AUX. PLANT	LOGAN UTAH	AUX. TO HYDRO PLT ○	1,403,280	400 KW.	——	——	——	——	675 1125 †	4 6		AIR	——	24	——	11.6	202.0	NONE	NONE	ABOVE GRD.	16,700	FROM CITY MAIN TO WASTE, CONT FLOW		42	110	NONE	NONE	——	MULTI-CELL	450	MANIFOLD	SOUND WAVE FILTER
MUNICIPAL UTILITIES	HARLAN IA	L & P	1,710,500	4,686	480	575	0.23	65.4 AVE	1-375 1-500 1-625 †	3 4 5	4	AIR	PISTON 3 STG.	34	142,000	11.02	1850	FILTERS	CENTRIF.	ABOVE GRD.	85,000	COOLING POND	CLOSED	● 100	120	80,000	ZEOLITE	7,200	MULTI-CELL	750	MANIFOLD	SOUND WAVE FILTER
MUNICIPAL ELECTRIC PLANT	McMINNVILLE ORE.	HEAT, L & P	3,400,000	9,400	—.	1,000	0.29	——	1 1500 † 1-600 2-300	6 6 6	2 4 2	AIR AIR SOLID	PISTON PISTON	28-32	142,000	10.4	1300	NONE	CENTRIF.	UNDER GRD.	25,000	CITY MAINS	——	55	110	——	——	——	NONE	700-200, 400-40 YL	MANIFOLD	
MUNICIPAL PLANT	ARCADIA WISC.	L & P	394,500	1,000 –1,200	—	150	——	——	2-120 1-300 †	2 6	4	SOLID	PISTON	30-38	——	——	——	NONE	NONE	ABOVE GRD.	15,000	CITY MAINS	——	60	110	175,000	NONE	——	——	——	MANIFOLD	SOUND WAVE FILTER
MUNICIPAL PLANT	WEST PT NEB.	GEN. L & P	1,000,000	2 740	200	350	0.124	——	2-150 1-400 1-680 †	3 4 6	2 4 4	AIR	PISTON	26-30	——	9.0	850	NONE	CENTRIF.	ABOVE GRD.	22,500	TOWER	CLOSED	80	105	5000	NONE	——	MULTI CELL -680	——	MANIFOLD	SOUND WAVE FILTER

▼ ALSO 1-1250 & 1-750 KW STM TURBINE Δ 24,000 GAL 2ND CLASS WATER FOR EMERGENCY ■ COMPLETELY AUTOMATIC PLANT □ FILTERS OF FELT & GAUZE AHEAD OF FUEL PUMP ○ MAIN PLANT THIS SEASON ● IN HOT WEATHER † INSTALLED DURING 1931 ▲ 3000 HP UNIT BEING INSTALLED

Large Plants and Large Units Characterize Hydroelectric Progress in 1931



Assembly of one of the waterwheel units for Diablo plant, a 90,700-hp. unit, 27 ft. head, 171.5 r. p. m.

MAGNITUDE is probably the one word that best characterizes the various developments that have occurred in the hydroelectric field during 1931. The large size of some of the hydroelectric plants that have been placed in service during the year and of others on which construction work has been done, as well as the extremely large size of some of the individual hydroelectric generating units that have been built, have served during the year to emphasize not only to the engineer but also to the layman the magnitude of the entire hydroelectric situation in the United States and the fact that the hydroelectric engineers of the country are thinking and working in terms commensurate with this magnitude.

As evidence of this characteristic, we may cite hydroelectric plants of as high as 250,000 hp. total capacity placed in service during the year and one plant now under construction to have an initial installation of 500,000 hp. Hydraulic turbines have been built in this period in capacities of 92,000 hp. for installation abroad and of 90,000 hp. for installation in this country. Besides this, the United States now contains a hydraulic turbine of the largest physical dimensions in the world, although it is not the largest in capacity and will probably be exceeded next year by turbines being built abroad.

In line with this same trend toward magnitude of project, some of the world's largest dams have been completed and put in service this year. Two of these are earth filled dams and one is a rock filled dam. A particularly noteworthy project was the building of a concrete dam on end and then knocking it over into place.

There has been considerable interest in and investigation of pumped storage projects in this country although none have been built during the year and little definite information has been issued in regard to these proposals.

Another interesting feature of the year's development is the placing in service of three large hydroelectric plants having outdoor or semi-outdoor generating units. A number of plants of this type are now in use in this country and some engineers believe that there is a marked trend towards this type of construction although many other engineers disagree violently with the idea.

Use of models for predicting performance of hydroelectric units and of hydraulic structures in general is becoming more widespread. There is considerable interest in the subject of automatic frequency and load control also in such subjects as reliability of hydroelectric units, height problems, forecasting of water supply, welding of runners and similar subjects.

Large Plants Began Operation This Year

Among the large projects placed in operation during the past 12 or 15 mo. and on which construction work has been proceeding for some time, the plants mentioned below are outstanding.

At Bingham, Maine, the Wyman Dam development of the Central Maine Power Co. was placed in operation with an initial installation of three 34,000-hp. units, or a total capacity of 102,000 hp. Fifteen Miles Falls Lower Development of the New England Power Association now provides 215,000 hp. of capacity, distributed over the first 220-kv. transmission lines to be installed in New England. In connection with the Fifteen Miles Falls development is the McIndoes Fall plant downstream, containing four propeller type water turbines, two of which are Kaplan runners, the total capacity here being 16,500 hp. In Michigan the Hardy hydroelectric plant of Consumers Power Co. has gone into service with three units developing 40,000 hp. total. Pacific Gas & Electric Co. has carried out a large scale development on the Mokelumne River in California to have a total ultimate capacity of 228,000 hp. Included in this development is the Salt Springs Dam, the world's largest rockfill dam, also the new Tiger Creek power house with a capacity of 72,000 hp. in two double overhung impulse waterwheel units.

On the Osage River, near Bagnell, Missouri, the Union Electric Light Co. of St. Louis placed in service during the year a hydroelectric plant with a capacity

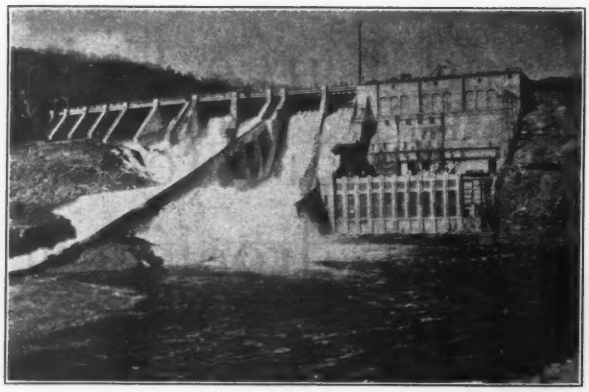


FIG. 1. WYMAN DAM DEVELOPMENT, 100,000 HP. CAPACITY, 135 FT. HEAD

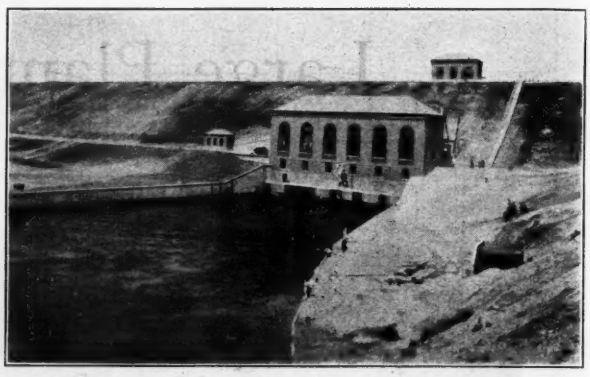


FIG. 2. HARDY HYDROELECTRIC PLANT, SHOWING PART OF THE EARTH DAM

of 268,000 hp. The Carpenter Dam plant of Arkansas Power & Light Co. on the Ouachita river has been installed with a capacity of 79,000 hp. in two units.

Saluda river development of the Lexington Water Power Co. in South Carolina includes the world's largest earthfill dam and a power plant with a capacity of 223,000 hp. While many other hydroelectric projects are under way and other smaller ones have been completed during the year, the plants named above are outstanding.

Large Plants Under Construction

Among the projects on which construction work is now going on, the largest, of course, is the Hoover Dam project, the initial installation of which will probably develop about 1,000,000 hp. This project was described in detail in the June 15, 1931, issue of Power Plant Engineering. The Safe Harbor development of the Safe Harbor Water Power Corp. on the Susquehanna River will have an initial capacity of 255,000 hp. in six Kaplan units and is planned for an ultimate capacity of 500,000 hp. The Ariel development of the Inland Power & Light Co. on the Lewis River in Washington is now under construction and is designed for an ultimate installation of 180,000 kw. or about 240,000 hp. On the Columbia River in Washington, the Puget Sound Power & Light Co. is constructing the Rock Island development in which a total capacity of 84,000 hp. in four units is expected to be ready next year. On the St. Lawrence River near Montreal, the Beauharnois Power Corp. is constructing an extremely large hydroelectric plant to contain an initial installation of ten 50,000 hp. units of a total initial capacity of 500,000 hp. Another Canadian plant that has attracted much attention is at Chute-A-Caron on the Saguenay River, where the Alcoa Power Co. is installing four 77,000-hp. units to give a total initial capacity of 308,000 hp.

Outdoor Hydroelectric Generators

It is interesting to note that several plants installed during the year were of the outdoor or semi-outdoor type, the latter including an extremely low and simple super-structure, often with a movable roof so that the crane running outdoors over the entire structure can lift the units through the roof. The Morony plant of the Great Falls Power Co. is of this type. The Bagnell development of the Union Electric Light Co. on the Osage river has 6 outdoor generators protected by metal casings with an outdoor crane running over them. At the Carpenter Dam plant the generating units are covered by a low superstructure with the crane running outdoors over it. A particularly interesting outdoor installation described in the October 15, 1930 issue of Power Plant Engineering is the Kaplan unit at Merced

FIG. 3. MODEL OF SAFE HARBOR DAM USED IN DESIGN OF PROJECT

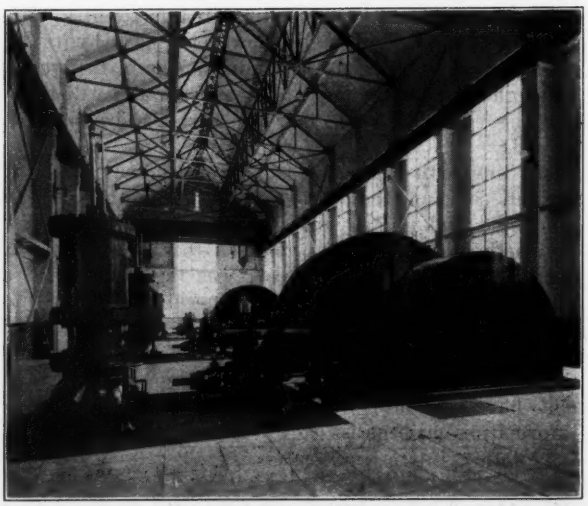


FIG. 4. TWO 30,000-KV.A. DOUBLE OVERHUNG IMPULSE UNITS AT TIGER CREEK

Falls in California installed with no building whatsoever around it. According to the data available at present, there are 12 plants in the country at present using outdoor or semi-outdoor generators.

The installation of 6 Kaplan units of 42,500-hp. capacity each at the Safe Harbor development has attracted much attention during the year. These units were made to practically the same design by two different manufacturers and the researches conducted at the Holtwood Laboratory were of the greatest assistance in the design of these units. Other particularly interesting uses of the Kaplan runner are illustrated in the Merced Falls plant and in the McIndoes Falls plant in connection with the Fifteen Mile Falls lower development as well as in a number of smaller installations that have been made during the year.

Among the large dams built and put into operation during the year, the Salt Springs Dam on the Mokelumne development is stated to be the world's largest rockfill dam. This is 328 ft. high with a crest 1300 ft. long and is 900 ft. thick at its base with a cubic contents of 3,000,000 cu. yd. of rock and granite. Another extremely large dam stated to be the world's highest earth dam is in connection with the Cobble Mountain development of the Springfield Water Works in Massachusetts. This dam, 245 ft. high and 1500 ft. wide at the base, has a hydraulic core with shoulders of sand, gravel, rock and boulder, the base of the dam being of rockfill. The dam for the Saluda project contains 11,000,000 cu. yd. of earthfill, is 208 ft. high, nearly a mile and a half long and a quarter of a mile thick at the base. The dam alone covers 105 acres. Another interesting earth dam, details of which will be given in a subsequent issue, was built in connection with the Hardy project of Consumers Power Co.

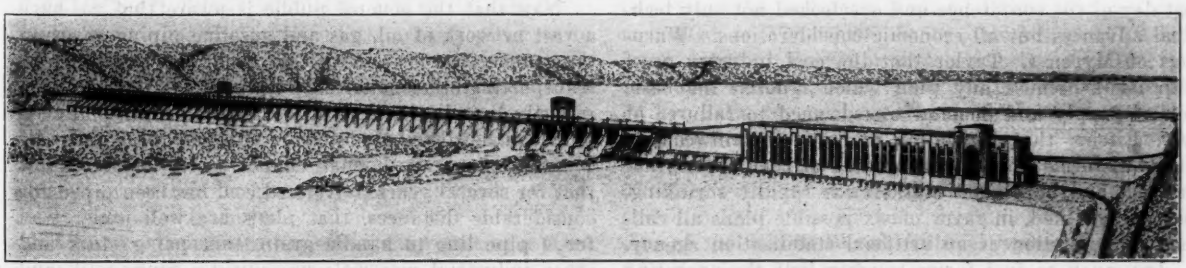
In the construction of hydroelectric projects, difficult construction problems are often encountered. One case that has attracted much attention occurred at the construction of the Chute-A-Caron project on the Saguenay river. It was desired to divert the river to another channel and a 92 ft. concrete coffer dam was built on end beside the river channel, one side of it shaped so that it would fit the bottom of the channel and then, by skillful use of dynamite, this block of concrete was toppled over into the river where it settled into place perfectly, formed the required coffer dam and diverted the river. Other interesting problems arose in connection with the Ariel project mentioned above, where in order to reach bed rock for the foundation of the dam, it was necessary to excavate to a depth of 123 ft. below the natural stream bed or to a point almost 74 ft. below sea level.

Large hydraulic turbine units built during the year include some 92,000-hp. waterwheels for the Dnieprostroy development in Russia and two 90,700-hp. waterwheel units for the Diablo project of the City of Seattle, Wash. These two 90,700-hp. units have the highest capacity of any built for installation in this country up to the present time. The largest unit in physical dimensions installed in this country now is stated to be the 57,000-hp. unit at Spier Falls, which has a runner diameter of 19 ft. 10½ in. For the Vargon plant in Sweden, however, Kaplan units are being designed to have runners over 26 ft. in diameter and when completed, these will be the largest in physical dimensions in the world, it is stated.

FIG. 5. OSAGE DEVELOPMENT UNDER CONSTRUCTION NEAR BAGNELL SHOWING SETTINGS FOR OUTDOOR HYDROELECTRIC GENERATORS

There has been considerable investigation of pumped storage developments in this country but aside from the Rocky river plant in Connecticut, no definite installations of these have been announced this year. In Europe twenty important pumped storage plants have been installed with a total turbine capacity of over 1,000,000 hp. American engineers are at present exhibiting much interest in these plants and in the whole subject of pumped storage.

Many interesting items of hydroelectric plant equipment have been developed during the year, one outstanding example being a gate hoist for the Chute-A-Caron development in which a fan connected to the hoist motor shaft controls the lowering speed of the gate. There has been much interest in automatic frequency and load control equipment which has been installed in two major plants, Norwood and Morony. Widespread use of models of water passages, hydraulic turbines and hydraulic structures in general continues as an aid both to designers and operators.



SAFE HARBOR DEVELOPMENT AS IT WILL APPEAR COMPLETED

Editorial Comment

Coal and the Power Industry

That coal as an industry is in a precarious condition is admitted by the industry itself. It is, in fact, shouted from the housetops together with demands for charity in the form of legislation,—any type of legislation.

In the face of the fight being waged against regulation and legislation by public utilities and railroads, it is difficult for one to understand the precipitous flight of the coal, and for that matter the oil industry to get caught in the same trap. To many it appears like selling their birthright of industrial freedom for a mess of government pottage. For a modicum of relief during a short period of depression, they are voluntarily shackling themselves with legislation which will be hard to throw off when the immediate crisis has passed. Legal difficulties in the way of artificial stabilization by legislation or even trade association agreements are, however, thought by many to be unsurmountable. Apparently help must come from another direction.

For six years, the Carnegie Institute of Technology has labored to be of assistance to the coal industry, upon which, to a large extent, the prosperity of Pittsburgh and Pennsylvania depends. No one can deny that they have done more than their part but indications are that the hindsight of the coal industry is little better than its foresight.

With an almost uncanny intuition of the needs of the industry, Dr. Baker arranged to review the progress of competitive fuels and of the coal using industries. Paper after paper reviewed the progress and achievements of chemistry, hydrogenation, synthesis, the growth of the natural gas and oil industries, plans of industries to utilize these new fuels at the expense of coal, pipe line distribution and production of products destined to undermine the market for coal byproducts. In spite of these developments and the disastrous experience of the past 10 yr. with low temperature carbonization, coal research is still pursuing the even tenor of its way toward carbonization. All constructive research came from outside the industry and will apparently stay outside the industry.

In fact, technical progress or assistance is apparently scorned. A special committee made up of five of the leading men in the coal industry and appointed "for bringing about the economic coördination of the coal industry" made a rather elaborate report on the last day of the conference and overlooked not only technical advances but all economic considerations. Warnings of Myron C. Taylor that the coal industry must help itself because any plan which ignored the basic law of supply and demand was doomed to failure; of Gov. Ritchie that legislation and government control were but forms of communism; and of competitors that the coal and byproduct market was rapidly shrinking, were sidetracked, in favor of six possible plans all calling for legislation as an artificial stabilization agency.

Inasmuch as fuel forms roughly half the operating cost of power, the future of coal is of more than passing interest to the power plant industry. Coal is not an ideal fuel, the annual freight on ash and moisture is a big item; heat loss in flue gas is important; ash disposal is a costly job; while fly ash, smoke and noxious gases are a sore spot in public relations and will be a source of great expense in the future. Corrosion due to sulphur has, it is estimated, caused a direct cost of $5,000,000 in three years in one metropolitan district alone.

For years the power industry has been looking for economical ways to eliminate these disadvantages. Recent advances in pipe line transportation, hydrogenation and synthesis with the development of non-inflammable liquid fuels suggests a possible way of processing coal at the mines and distributing it as liquid or gaseous fuel through pipe lines. Annual savings to the power companies in construction costs and operating expenses would be measured in millions of dollars.

Such potential possibilities should make it worth while for the industry as a whole to finance research along modern lines. Obviously the coal industry is committed to a program of relief by legislation and to research along the rut of carbonization, both of which will mean higher instead of lower fuel costs to the power industry. Even those plants which can turn temporarily to competitive fuels must some day return to coal because natural gas cannot be expected to supply the entire fuel needs of industry and the increasing demand for higher yields of gasoline will curtail fuel oil or at least set a price that will be prohibitive for power plant fuel.

In self defense, the power industry must cooperate with the fuel industry and develop methods of processing coal at the mines which will give the ideal fuel. Cooperation and research now while the coal industry is at a low ebb will be effective. A few years hence, with the natural gas supply decreasing and oil diverted to other than power fuel uses, the coal industry, well organized, will be again in the saddle. Fuel prices will increase and, as rate increases are more difficult to justify than rate decreases, the power industry will find itself in the present position of the railroads. The choice should not be difficult to make, nor the research difficult to justify.

The Piping Times of Peace

Now that the general public is aware that we have a vast network of oil, gas and gasoline piping covering the country, we hear much talk about the possibility of transporting other materials by pipe line. Laymen have recently been heard to predict that coal, grain and even milk can be distributed to our cities by pipe line. Of course, the average layman cannot be expected to know that for several years pulverized coal has been piped for considerable distances, that plans are well under way for a pipe line to handle grain, that paper stock and other industrial materials are piped. Since milk and

oil are both liquid. he reasons, "why cannot milk be piped in the same way?"

The layman's imagination is stirred by the thought of having in his kitchen a shining faucet from which he can draw fresh milk, piped right from the farm via this tremendous pipe line system that someone is to build. "Why not?" asks the layman. "These engineers cannot surprise us now. Almost any fantastic scheme that can be suggested to them may soon become a reality." Well, nothing seems impossible nowadays, we admit. But the man who has seen the inside of equipment in a dairy after a few hours of operation, when it is taken apart for scalding and thorough cleaning, will not be overly optimistic about the possibilities of piping milk 75 or 100 mi. into New York or Chicago from the dairy districts.

Lest the public, in its enthusiasm, becomes too avid for progress that it cannot pay for, it may be well to call attention to several factors that tend to retard the development of pipe lines for many of our raw materials.

First, we have elaborate systems of railroad and highway transportation, competing with each other and with pipe line transportation.

Second, we have the factor of what Stuart Chase has called technological tenuousness; that is, the use of a system that might be put out of action by an accident. Suppose milk for a large city were piped by a long line and an accident of some sort necessitated shutting off the line. What would it cost to provide a reserve method of supplying the milk until the line could be repaired? The layman has no conception of the precautions taken by public utility companies to insure continuity of service on oil, gas, electric distribution systems. These precautions cost money. But service must be reliable, above all things.

Thus any pipe line system for handling milk or any other product must justify itself on many grounds, not the least important of which is that of competition with existing methods, with all the political and economic controversy that implies.

We do not mean to suggest that pipe line systems will be confined solely to the countrywide distribution of oil and natural gas. Without doubt engineers will develop, in the future, methods of piping other materials. It would seem, however, that the present success of the gas and oil line development should not be permitted by engineers to lead the public into unwise beliefs and possible rash courses of action. Engineers can do much to insure the proper development of pipe line systems by insisting that they should be based on sound engineering and by stating the facts in no uncertain terms to the public.

Factors in Engineering Development

In presenting the review of the year's progress in the power field in this issue, we have called attention to the fact that the developments this year were more in the nature of slight improvements and refinements rather than in spectacular or revolutionary changes in design or practice. In one or two instances, perhaps, such as at Bremo, designs of quite a different character from standard were introduced but even these, when analyzed, prove to have been the result of a more or less gradual evolutionary process in the last few years. Now it might be concluded that this lack of spectacular development is a consequence of the general economic depression; that, since business has been poor, there has been a slowing up of engineering effort. Although we realize that this may be a factor, it is one which, in our opinion, is negligible and the real reason must be looked for elsewhere.

As a matter of fact, this slowing up of development is more apparent than real. The total number of new developments per year today is vastly greater than it was 20 yr. ago and 20 yr. ago the number undoubtedly was vastly more than it was 20 yr. previous to that. Years ago progressive ideas were received with reluctance and skepticism. Imprisonment and persecution were often their reward. Today, novel and important scientific and engineering improvements are encouraged and are being introduced at the rate of thousands every year.

Now it is this very fact that brings about an apparent slowing up in the process of assimilating these improvements First we have grown to expect more; second, there is a limit to the rate at which manufacturers and users of equipment can absorb new ideas and developments. Improvement requires change and, if everything should be changed too frequently, the volume of production or the cost of the product could not be maintained.

Merely because of the fact that today somebody brings forth an idea for making a better boiler, a more efficient pulverizer or a more effective circuit breaker, does not imply that all existing boilers and pulverizers and circuit breakers can be scrapped immediately and the new types installed. In the same way, there are limits to the extent to which or the rate at which even admittedly important improvements can be made in a product. Time is required for the absorption or the assimilation of new ideas and when we come to a time, such as we suspect is the case at present, when the number of new ideas exceeds the rate at which they can be absorbed, there is an apparent slowing up of development.

Many new things are in the wind today but a certain amount of time will be required to bring them to commercial success. The embodiment of a new principle in a machine or process is now in most instances a far more elaborate undertaking than it was in earlier periods. Thus, while there have been rumors for several years of such startling things as high-voltage, direct-current transmission and hydrogen-cooled generators, no actual commercial applications of these ideas have as yet been made. Undoubtedly they will come, however, and when they finally do, they will no longer seem new.

ELECTRIC OUTPUT for subsidiaries of National Electric Power Co., including National Public Service Corp., amounted to 179,400,000 kw-hr., according to preliminary reports. This represents an increase of 16.9 per cent over October, 1930, when output was 153,500,000 kw.hr. Adjustments have been made for properties acquired within the year, to place the figures on a comparable basis. For the first 10 months, output was 1,730,000,000 kw-hr., an increase of 17.6 per cent over the same period in 1930. The National Group is the Eastern division of the Middle West Utilities System, serving the Atlantic Seaboard area.

International Coal Conference at Pittsburgh

THIRD INTERNATIONAL CONFERENCE ON BITUMINOUS COAL HELD UNDER AUSPICES OF CARNEGIE INSTITUTE OF TECHNOLOGY, NOVEMBER 11 TO 14, BRINGS TOGETHER OVER 1200 ENGINEERS, RESEARCH MEN AND COAL OPERATORS FROM ALL OVER THE WORLD TO DISCUSS THE PRESENT PROBLEMS OF THE COAL AND RELATED INDUSTRIES

FLANKED BY FLAGS of the participating nations, Dr. Thomas S. Baker, president of Carnegie Institute, founder and chairman of the Conference, opened the first meeting with an address outlining the purpose and aims of the Institute in sponsoring the assembly. "It has been the object of these Carnegie world coal congresses to assemble as much as possible of the scientific data from all parts of the world and to place them before the American technologists and mine owners—but we recognize that science alone is powerless to rescue the coal industry in the crisis at which it now finds itself.

That the coal industry itself must be the major factor in improving economic conditions in the industry was emphasized by several speakers, especially by Myron C. Taylor, chairman of the finance committee, United States Steel Corp. He said, "The primary responsibility is on the industry itself to find ways to promote the public interest and the interest of its own producers, employees, distributors and customers by making and carrying out whatever constructive plans may be permissible. Basic supply and demand inevitably reflect prices in the long run. Artificial measures looking toward price control are sure to break down eventually. . . . I shall be disappointed if it mistakenly settles down to the view that nothing can be expected until additional legislation is enacted."

Further warnings of dangers lurking in legislative help and government assistance were voiced by Gov. Albert C. Ritchie of Maryland who is "convinced that the bituminous coal industries and every other industry as well can put its house in order and prosper as prosper it should, under a policy of non-interference better than it can by anything the government can do."

Some 50 methods or proposals for stabilization of the bituminous coal industry made during the past 15 yr. were tabulated and discussed by Dr. L. E. Young, vice president, Pittsburgh Coal Co. These proposals ranged from trade association agreements to complete ownership of coal lands by the federal government. He concluded with "opinion is changing . . . particularly on principles that are fundamental in planning for the stabilization of the bituminous coal industry. The trend of thought appears to be away from nationalization and federal control; away from fixing prices and wages by law; away from federal control generally and toward state control and state compacts."

Of the many proposals one modeled after the action of the governors of the oil producing states in limiting petroleum production seems the most practical at the present time. This scheme was discussed in considerable detail by Dr. W. T. Thom, Jr., of Princeton University. Following a Washington Conference of representatives of the eight oil producing states where Secretary of the Interior Wilbur pointed out the need for an interstate compact which could and would insure rationalized production, state oil production quotas were agreed upon. In September three states, Oklahoma, Kansas and Texas, signed a compact. As a result, the feeling is abroad that the oil industry has passed the crisis and will soon be restored to economic health.

As a result of the first day's deliberations a resolution was adopted requesting Dr. Baker to appoint a committee to investigate proposals for economic coordination of the coal industry. The committee composed of Walter H. Glasgow, secretary of the Pennsylvania Bureau of Mines; C. E. Lowell, director School of Mines, West Virginia University; J. J. Rutledge, chief mining engineer, Maryland Bureau of Mines; F. R. Stearns, director of the Stearns Coal & Lumber Co.; examined a number of proposals and reported—"that the plans presented such divergent views on the subject that it would be impossible to co-ordinate the suggestions into one policy. Six plans outlined depend upon cooperation of companies, associations or states, the seventh would require modification of the anti-trust laws and the establishment of a national production board with broad powers. Nationalization was not mentioned but one plan called for the declaration of coal as a public utility under the regulation of a public utility committee. By vote of the conference delegates Dr. Baker was authorized to send the report to the governors of the coal producing states.

Looking forward in the light of chemical advances made during the past few years, the predictions of Dr. William J. Hale, Dow Chemical Co., offer the most logical solution of the coal industry ills. Placing carbon monoxide (CO), ethylene (C_2H_4) and acetylene (C_2H_2) as the basic raw materials of industry, Dr. Hale pointed to research as the only salvation of the coal industry. Abandonment of present byproduct manufacture for the production of these three products from coal and water at the mine and the distribution of them or their derivative as gas or liquid in pipe lines to all parts of the country was suggested. He pointed out the futility of making byproducts that can be made more cheaply in the laboratory and mentioned that even phenol and ammonia can be made more economically by synthesis than from coal.

By intensive research, chemistry has taken away from the coal industry everything but the fuel market; that is, coal and coke, and even this is being cut into by natural gas, oil, petroleum coke and increased efficiencies of coal burning equipment in industries such as the public utilities. Whether Dr. Hale's suggestion of processing the coal at the mines and distributing the derivatives in pipe lines would be practical or economically feasible in the face of natural gas competition is a problem for the industry to solve.

In the face of the many papers on low temperature carbonization, high temperature carbonization, gasifica-

tion and byproducts and the high quality of the many papers, it does not appear that the frequent charges that the industry is neglecting research are substantiated. Progress made and reported from the natural gas, oil and organic chemistry laboratories, however, indicates that coal research has perhaps taken the wrong road and that Dr. Hale's warning, "forget carbonization, forget byproducts and think only of the present raw materials of industry, carbon dioxide, ethylene and acetylene", will bear close scrutiny.

This warning was sounded by other than chemists. Dr. R. P. Soule, Tri-continental Corp., who was closely identified with low temperature developments, in a paper which he said might well be alternately called "Low-temperature carbonization: Its rise and fall", remarked: "There appears, however, no really strong case to be made for low temperature tar under existing American conditions. Failing this, the case for low temperature carbonization itself must collapse." The one ray of hope mentioned by Dr. Soule and emphasized later by Dr. Gustav Egloff, Universal Oil Products Co., is in the ease with which those tars can be cracked to produce a gasoline of high anti-knock properties. Under present conditions, however, there is no incentive to crack.

Along the same line, W. H. Fulweiler, United Gas Improvement Co., reviewing the future of manufactured gas from the standpoint of the utilization of natural gas, refinery vapors, coke oven gas and pipe line transportation, reaches the conclusion that "the gas industry has developed slowly but surely, it has met many crises and looks forward to the future with assurance that it would be able satisfactorily to solve its problems so that it may continue to say, If it's done with heat, you can do it better with gas." All in all, the future of the coal industry appears to lie in itself, largely through cooperation, and not competition, with related fuel industries.

Aside from the above general papers throwing some light on future trends of fuel practice, papers of direct interest to the power plant field were grouped in three sessions, pulverized fuels, power plant fuel and coal cleaning. Some of these papers will be covered in greater detail in later issues.

One of the most practical and valuable papers was that presented by E. H. Tenney, Union Electric Light & Power Co., on theoretical and practical aspects of pulverized coal firing. This paper, a comparison of the turbulent and steam line burners under the same conditions, presented results of temperature, velocity and gas analysis studies in all parts of the furnace. In the same session, E. G. Bailey and R. M. Hardgrove, Fuller Lehigh Co., described the evolution of the slag tap furnace with particular reference to the new castiron-block water cooled construction.

In stoker firing, revolutionary changes were advocated. Bert Houghton, Brooklyn Edison Co., in discussing underfeed stokers advocated a light uniform fuel bed with no humps, and 0.5 in. draft in the furnace. Data and photographs showing fan power savings, improved combustion and better furnace conditions were presented. Referring to German chain grate operation, Dipl. Ing. Friedrich Schulte described chain grate furnaces with no arches of any type and used for burning all types of coal. Test results showed where chain grate stokers had been pushed from 50 to well over 100 per cent rating in 15 sec., faster than any other type of firing not excluding gas and pulverized fuel.

An entire session was devoted to studies of the theoretical mechanism of combustion of pulverized coal and solid fuels. Papers by Andre Grebel, France; Y. Oshima and Y. Fukuda, Japan; S. P. Burke, T. E. W. Schumann and R. A. Sherman, United States, indicate a better understanding of this complex process. Although all were in the nature of progress reports, theoretical results check well with practice and open the way for well directed future investigations.

Somewhat along this same line was the investigation reported by Tetsuro Suwa, Japan, on investigations of combustion conditions of a coal dust engine. High combustion ratios and pre-combustion chambers are recommended. This investigation was purely theoretical in contrast with the paper by Rudolf Pawlikowski, Germany, who discussed the experimental developments of the Rupa powdered coal engine by the Kosmos Co. which rebuilt six engines in order to study combustion and operation in the several types.

German practice for transportation of pulverized coal in pipe lines and tank cars was outlined by Dilp. Ing. Friedrich Schulte. Pneumatic conveying can be by suction or pressure, the former being limited to about 450 yd., the latter to 2000 yd. In discussion, C. J. Jefferson, Kennedy-Van Saun Mfg. & Eng. Corp., described a pressure system now used in Russia for maximum distance of 3000 yd.

Railway fuel, steamship fuel, domestic fuel and smoke abatement were the subjects of separate section meetings. In one of these Leopold Herry, Belgium, described the proposed utilization of coal at Langerbrugge Station. This program calls for two subsidiary companies, the first for handling the carbonization process, the second for the tar utilization and cracking. Production is based on 250,000,000 kw-hr. per yr. which will require about 150,000 t. of semi-coke from 200,000 t. of coal and will give 8,000,000 liters of gasoline, 6000 t. of rubber substitute and 1800 t. of aluminum.

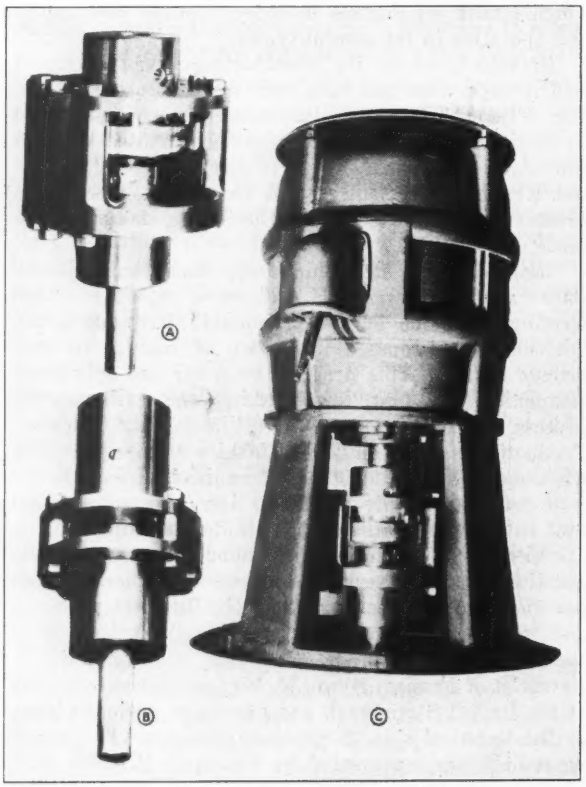
With increased efficiency in coal burning processes, the question of ash and rock in coal becomes of increased importance and the cleaning of coal by different processes and by different countries was made the subject of a special meeting. W. R. Chapman of England; C. Berthelot of France; Byron M. Bird and Thomas Fraser of the United States each had papers on various phases of the technical side of cleaning processes. The power plant field was represented by Edwin B. Ricketts, New York Edison Co., in a paper on the value of clean coal for steam production. Formulas were given for calculating the effects of variations in ash content and the cost of steam generation. Constants used were determined experimentally for three large boiler plants.

During the conference, which lasted four days, over 100 papers were presented in some 26 meetings, sometimes with as many as five simultaneous sessions. In addition there was one evening meeting in which Norman McClintock, Koppers Research Corp., showed moving pictures illustrating the effects of coal distillation byproducts on agriculture, and a banquet at Hotel Schenley presided over by Dr. Baker at which many of the foreign representatives gave short addresses. Somewhat over 1200 delegates registered, many of these staying over several days to take advantage of some of the many inspection trips arranged to plants over the east and middle west.

Power Plant Engineering Developments and News

Vertical Pump Coupling

RECENTLY a new coupling has been designed by Ideal Electric & Mfg. Co. of Mansfield, O., which permits raising or lowering the pump shaft a short distance to give proper clearance for the pump rotor, without the use of a hollow motor shaft. This makes it possible to use direct current or synchronous slip-ring a.c. motors as well as the squirrel cage a.c. which have generally been used. For pump overhaul, the motor need be raised only the slight distance to clear the coupling, with no special care needed to maintain alinement.



A. BACK-SPIN RELEASE COUPLING
B. DOUBLE THRUST COUPLING
C. MOTOR WITH TYPE A COUPLING

Typle A has back spin release to prevent such unscrewing of the pump shaft as would uncouple the sections. The upper hub, which is bolted to the lower end of the motor shaft, carries a plate in which are drive pins. The lower hub, which is keyed and locked to the pump shaft, has an engaging plate at the top into which the drive pins fit during normal operation. When a back spin of the pump rotor occurs and the shaft tends to unscrew, the shaft will lengthen until the pins disconnect from the engaging plate, leaving the pump shaft free to spin without further unscrewing so that uncoupling of shaft sections will be avoided.

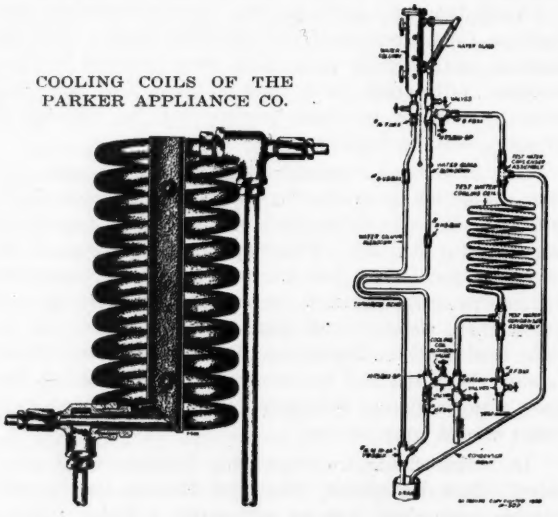
Type B, the smaller coupling shown, carries thrust either upward or downward, the upper and lower hubs being bolted together. In both types, the top end of the pump shaft is threaded and can be adjusted in the lower hub by a nut to raise or lower the rotor, then is locked by pressure on the key.

View C shows a type A coupling attached to a vertical motor which is mounted on its supporting base.

Heat Exchange or Condensate Coil

PERIODIC SAMPLING of boiler water and continuous blowdown of water column is current practice in power plants. In many plants, boiler water is sampled at short intervals in many places throughout the plant—in some instances, as many as 30 condensate coils are installed in a single plant.

The tubular unit illustrated at the left, and built by the Parker Appliance Co., Cleveland, O., is composed of two tubes, one within the other, thus providing a space between the tubes through which the coolant flows. Steam from the boiler is conducted through the inner tube and the condensate is drawn continuously or as may be desired from the other end of the coil.



COOLING COILS OF THE PARKER APPLIANCE CO.

Special combination fittings for connecting the several tubes are an outstanding feature of this coil. The

fittings are of Parker tube couplings of a design which permits connecting the coil to the steam line with practically no contact of the steam directly with the bronze fittings. This permits the use of this coil in high pressure high temperature lines with safety. A Monel metal fitting is commonly used in high temperature lines at the steam line or water column, with a steel or Monel valve for controlling the steam flow through the coil.

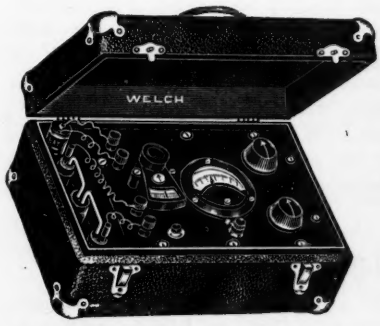
Water at any desired pressure is introduced into the space between the tubes through the side outlets of the bronze fitting. This coil is compact and of light weight, but rugged and capable of withstanding the most severe service encountered in a power plant. Samples of boiler water may be taken without disturbing connections and with the greatest facility. At the right is illustrated a typical coil hook-up with provision for blowing down both water column and gage glass line.

pH Determinations

HYDROGEN Ion concentration measurement can be rapidly made by the use of the quinhydrone electrode, balancing the unknown potential against that of a known potential on a potentiometer. Such an instrument has been developed by Dr. W. J. Youden of the Boyce-Thompson Institute of Plant Research in Yonkers, N. Y., and manufactured by W. M. Welch Mfg. Co., 1615 Sedgwick St., Chicago, Ill., who, in working in conjunction with Dr. Youden, have produced a set with the following features:

It is compact, mounted in a box with potentiometer, millivoltmeter, galvanometer, and all electrodes included. There is no standard cell needed in this method of comparing voltages so that this troublesome element is eliminated. Quinhydrone functions only up to 8.5 and above this point the calomel or hydrogen electrodes should be used. This may be connected in place of the quinhydrone electrode setup.

A set of this type with quinhydrone electrodes may be carried out in the field. No solutions need be mixed in the field and a comparatively inexperienced or non-technical operator may make the tests. It has been used in making tests of ground waters, soils for golf links, etc. The degree of accuracy is .03 ph and the range is from 1.41 up to 8.5, the limit of the quinhydrone, and from there on with the calomel and hydrogen electrodes.



PORTABLE INSTRUMENT FOR pH DETERMINATIONS AS MANUFACTURED BY W. M. WELCH MFG. CO.

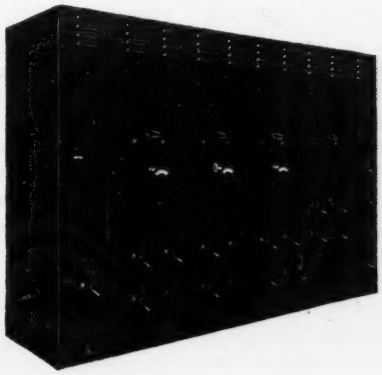


FIG. 1. BULL DOG SAFTOSWITCH-BOARD

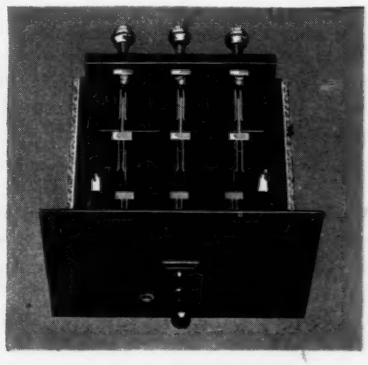


FIG. 2. BULL DOG BALL BEARING SWITCH

New Switchboard Has Ball Bearing Switches

TO MEET the mobile and flexible requirements of modern distribution systems, the completely standardized SAFtoSwitch-Board of sectional unit construction and featuring ball bearing switches, is announced by Bull Dog Electric Products Co. of Detroit.

This is a dead front totally steel enclosed switchboard and consists of an assembly of standardized sectional panels, all parts of which, such as steel frames, steel enclosures and ball bearing switches, are also of standardized unit construction. The sectional unit construction provides greater mobility and flexibility to take care of changes and future extensions and likewise ensures 100 per cent salvage.

The Ball Bearing switch incorporated in this board is unique. The ball bearing guides secure frictionless switching and are thus a compensating factor against usual wear; they also permit full floating positive contact and ensure simultaneous double break. It is a self contained safety switch of unusually compact and durable design, embodying separate fuse and switch compartments interlocked for safety in replacing fuses. The standardization provides for the interchangeable mounting of these ball bearing switches for all polarities, all capacities and all voltages and further covers the inclusion of standard air circuit breakers, oil breakers and meters, where required.

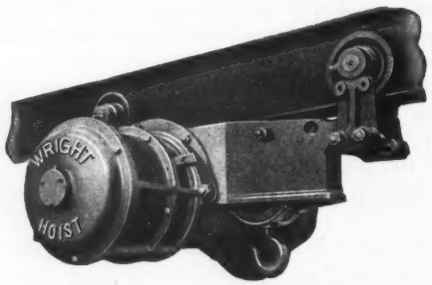
Lighter, Smaller Sunlamp Models Announced by General Electric Co.

WITH THE DEVELOPMENT of the smaller Type S-2 Sunlight Mazda Lamp, a new line of Sunlamp fixtures, lighter in weight, and less expensive, has been announced by the Merchandise Department of the General Electric Co., Bridgeport, Conn.

The S-2 lamp, used in the new model K, L, M and P fixtures, consumes only 175 w. as compared with 450 w. consumed by the Type S-1 lamp, and provides 75 per cent as much ultra-violet radiation as the larger lamp. The lightness and compactness of the new fixtures are partially accounted for by the use of a smaller transformer. The new models, offered as an addition to the present type of Sunlamps, complete a line of 10 models.

Electric Hoist for Minimum Headroom

TYPE WH ELECTRIC HOIST, designed for installations where headroom conditions are such that no other type of electric hoist can be used, has been developed by Wright Mfg. Co., Bridgeport, Conn. For example, with this hoist the minimum distance from the bottom of the I-beam to the hook on the one-half ton hoist is 11 in. and on the one-ton hoist 13 in. It is designed to meet minimum headroom conditions and still keep



TYPE WH ELECTRIC HOIST

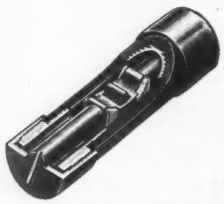
the hoist drum and sheaves of ample size to prevent excessive cable wear.

This hoist also includes such features as push button or pendant rope control, optional at same price; Tru-Lay Preformed cable; safety type limit switch, safety type load block, positive mechanical brake, oil bath lubrication and heat-treated forged gears and pinions.

AE Fuse

WHAT is claimed to be a new principle of fuse construction is introduced by the Associated Engineers Co. of Chicago in a new renewable fuse, to be known by the trade mark, AE.

The design of this new fuse departs from the use of nuts, bolts and washer, as a means of making link and



CONSTRUCTION DETAILS OF AE FUSE

terminal contact. The accompanying illustration shows how the link is formed to fit on a rigid asbestos carrier, positive link and terminal contact being made by terminal pin abutment. This view also shows how a part of the carrier projects between the calibrated portions of the link, to make an effective arc barrier between the link's main section. Because of the reduced length of its renewable link and its abutment contact, it is stated that the AE Fuse will operate with remarkable coolness and with a dependable time-lag which, it is claimed, eliminates unnecessary opening of the circuit and yet assures a maximum of protection under all conditions. In renewing the link, there is no chance for error, it is stated, and no tools are required.

WHIPPING BELTS indicate lack of flywheel effect in the drive.

Brick from Fly Ash

RESULTS of long investigation as to possibilities of utilizing fly ash were recently presented to the Prime Movers Committee of N. E. L. A. at its Purdue University meeting by Professor H. C. Peffer, head of the department of chemistry.

The brick and tile shown have been given the name Ross-stone. This is produced by a chemical reaction, in a process requiring no burning, by the use of ordinary press brick machinery. From the start of the process to finished brick requires some 48 hr., the brick being of uniform texture with a smooth surface. Weight is 4½ lb. for the common size of building brick, crushing strength, 10,000 lb. Water absorption is some 9 per cent with no effect on strength; mortar adhesion is good and breakage by chipping is about the same as for ordinary brick.

As tile, a pleasing surface is presented with sharp corners and square edges, any color darker than that of fly ash being obtainable by admixture of mineral pigments. It is possible to color to any desired depth from the surface, thus effecting a saving in the expense of coloring. Tile with polished surface, exposed to weather for a year showed no signs of deterioration of body or surface.

While the product has not been made commercially as yet, it is estimated that the cost will enable it to compete with ordinary No. 1 clay brick for building. Material from slag-tap bottoms can be mixed with the ash, giving greater porosity but greater strength. Some 2¼ t. of ash are used per 1000 brick, the room required for a plant being about the same as for an ordinary brick plant, without the kilns, as the ash brick are not burned or baked.

News Notes

ASHTON VALVE Co., Cambridge, Boston, Mass., announces that effective November 15, Edward C. Kenyon is appointed Pacific Coast representative with headquarters at 606 Howard St., San Francisco, Calif., where he will be in charge of sales of the Railroad and Industrial Departments. Mr. Kenyon was previously located at the Chicago office of the company.

ON NOVEMBER 13, the Grindle Fuel Equipment Co., for the past 10 yr. a subsidiary of Whiting Corp., Harvey, Ill., was absorbed by the parent company and from now on will be operated as a separate department under the name Pulverizing & Combustion Equipment Division. W. R. Bean, formerly president of Grindle Fuel Equipment Co., has been made a vice-president of Whiting Corp. in charge of the newly formed division.

U. S. PATENT No. 1,828,618 was issued to the Plibrico Jointless Firebrick Co. on October 20, 1931. The patent is for anchors designed to allow expansion and contraction of a monolithic furnace lining and it illustrates and describes the Flexo-Anchor, which it is the practice of the company to furnish to its customers. The Carolina Refractories Co. has a limited license for a chain type of anchor.

WICKES BOILER Co., Saginaw, Mich., announces the installation of a modern X-ray machine and complete laboratory facilities, to provide the Wickes shops with the necessary equipment to fabricate welded pressure vessels and power boiler drums strictly in accordance with the A.S.M.E. Fusion Welding Codes.

ACCORDING to a recent announcement, the Mason Regulator Co. has acquired the Neilan Company, Ltd., Los Angeles.

Complete engineering, manufacturing, sales and service activities will be maintained in both Boston and Los Angeles. The distribution network is, of course, considerably broadened. Mason-Neilan offices, manned by engineers familiar with the consolidated line of control equipment, are now established at the following points: Boston (Mason Regulator Co., 1190 Adams St.); Los Angeles, (641-651 Santa Fe Avenue); New York (19 Rector St., R. B. Werey in charge); Chicago (400 No. Michigan Ave., under the direction of Arthur J. Foley and William P. Gearon); Pittsburgh (1301 Clark Bldg., in charge

of Bruce Irwin); Montreal (Mason Regulator Co. of Canada, Ltd., 686 Notre Dame St. West, under the direction of H. L. Peiler and M. F. Peiler). In addition to these main distribution points, stocks are to be carried in at least 32 other cities in the United States. World distribution will be maintained through the foreign connections of the Mason Regulator Co. at London, various Continental points and in Australia, New Zealand and the Far East.

THE AIR PREHEATER CORP., Wellsville, N. Y., announces that it is now represented in Washington, D. C., by Irving M. Day, with offices in 306 Chandler Building.

KIELEY AND MUELLER, Inc., is completing arrangements for production at its new plant, 40 Paris St., Newark, N. J., where 25,000 sq. ft. of floor space will be devoted to the manufacture of its full line. Production schedules call for work to start shortly after the first of the year.

From this new plant, located 20 min. from New York on the express highway, shipments can be made at considerable saving and with greater facility, it is stated. The main office of Kieley and Mueller will remain where it has been for over half a century at 34 West 13th St., New York, where also a warehouse with complete stock will be retained for servicing the metropolitan area.

BUBBLE TOWER or fractionating column 12 ft. in diameter and over 93 ft. long was recently constructed by The Babcock & Wilcox Co. for the Lummus Co. This unit is to be erected in the Bayonne, N. J., refinery of the Tidewater Oil Company and will be used in producing high quality gasoline of the modern anti-knock quality. The bubble tower receives mixed vapors and liquids, separating the gasoline by fractionation.

To meet the demands of this process the tower is built to withstand a pressure of 150 lb. per square inch and temperature of the order of 700 deg. F. It weighs over 325,000 lb.

All the joints and seams of this tower were made by the B. & W. fusion welding process and to check the welds, photographs of the seams were made with a powerful X-Ray machine employing tubes actuated by 230,000 v.

After the welding was completed, the tower was placed in an enormous furnace and given a strain relieving heat treatment of several hours at approximately 1200 deg. F.

Books and Catalogs

HEAT ENGINES, by John R. Allen and Joseph A. Bursley; Fourth Edition, published by McGraw-Hill Book Co., Inc., New York, N. Y., 6 by 9 in., cloth, 526 pages; price, $4.00.

Rapid progress in the development of heat engines and boiler room practice is reflected in this edition of the book which, since the first edition in 1910, has remained consistently an elementary textbook. Chapters on heat, properties of steam, elementary thermodynamics, fuels and calorimeters take some 125 pages of the book, the balance being devoted to boilers, steam engines, steam turbines, internal combustion engines and their respective auxiliaries. All material has been brought up to date particularly with respect to properties of steam and in compliance with the recommendations of the American Standards Association as to symbols and abbreviations.

STEAM TURBINE OPERATION, by William J. Keaston; published by Isaac Pitman & Sons, 2 W. 45th St., New York, N. Y.; 5½ by 8½ in., cloth, 293 pages; price, $3.75.

In spite of the large number of books dealing with steam turbines, the operating engineer has been almost completely neglected. This condition has been rectified by the publication of this book which may well be termed the operating engineer's textbook in contrast to the student's and designer's textbooks delving deeply into the realm of theory and design.

In as far as possible definite instructions for operation are included but the major portion of the book includes such descriptive matter as will enable the operating engineer to understand better the construction an operation of the plant under his care. Thermodynamics in as far as it relates to turbine operation has not been neglected but is included with practical applications in a 50-page chapter on turbine testing.

The work is divided into 10 chapters, beginning with the installation of turbines and carrying through to proper heating and draining, types of shaft glands, lubrication, governors, starting and stopping, inspection, troubles, and turbine testing with a concluding chapter on the Ljungstrom turbine. Although written by an Englishman with a British point of view and using a large number of illustrations from British manufacturers, American turbine construction is well covered. Furthermore such illustrations as are used are largely diagrammatic, intended, with the descriptive matter, to give the reader an understanding of the principles of operation rather than specific details applicable to one particular machine and intended to take the place of the manufacturer's instruction book. As a manual of operation and a general reference, the book deserves a preferred position on every power plant shelf.

STEAM POWER AND INTERNAL COMBUSTION ENGINES, by Dudley P. Craig and Herbert J. Anderson; published by McGraw-Hill Book Co., Inc., New York, N. Y.; 6 by 9 in., cloth, 460 pages; price, $4.00.

Modern power plants are presented by descriptions of modern equipment and methods of adapting them to power units with sufficient historical background and fundamental principles to make it of interest to the engineer or student. The first chapter deals briefly with the major equipment and arrangement of simple power plants while the succeeding chapters discuss individual parts of the plant in considerable detail. About 30 p. are devoted to elementary thermodynamics and about 26 to fuels and combustion. Although the 55-page chapter devoted to internal combustion engines may seem short, considering the importance given this equipment in the title, it is consistent with the importance of the internal combustion engine considered as a prime mover as the steam engine chapters total but 52 p. and the steam turbine chapter 60 p. Because of the space devoted to practical equipment descriptions, the book is of more value to the practical engineer than is the usual textbook.

THE STEAM ENGINEER is the title of a new periodical of which the first issue appeared as of Oct. 1, published in London, England. Under editorial direction of John D. Troup, its announced purpose is to collect all the economic factors governing the field of steam engineering. Articles in the current issue cover steam generation for heating, for electric stations, for steamships, thermal storage, power generation and reports on progress.

ONE HUNDRED AND FIVE applications of instruments to the steam power plant for measuring temperatures, pressures, flows, liquid level, CO_2, and speeds are discussed in detail in a recent letter-size 50-page bulletin issued by the Brown Instrument Co., Philadelphia, Pa. Part I of the bulletin discusses the general applications of measuring instruments to the factors of fuel, combustion, steam generation, prime movers, feedwater systems, condensing systems, auxiliaries, electrical systems, and gives a large diagram of a typical power plant showing where the instruments should be applied. Part II of the bulletin notes the principles of the instruments, shows and describes the models, gives the ranges to which they are applicable and presents tables of applications.

RECENT PUBLICATIONS issued by the General Electric Co. include the following which may be of interest to those in the power industry: GEA-1312, a 100-page bulletin entitled Rubber and Miscellaneous Cable, presenting a compilation of information on all types of rubber insulated cable including data on the relation of cables; GEA-1463 entitled Automatic Switchgear and associated supervisory systems for railway service, a 24-page bulletin containing a series of articles reprinted from the General Electric Review; GEA-1464 entitled Automatic Switchgear and associated supervisory systems for industrial service, also reprinted from the General Electric Review; GEA-720B on Direct Current high speed circuit breakers and GEA-310D describing Insulator Units.

AMSCO type "C" material handling pumps for handling abrasive mixtures are described in detail in an illustrated booklet just issued by the American Manganese Steel Co., 389 East 14th St., Chicago Heights, Ill.

PARKER CONDENSATION COILS are described in bulletin No. 29; tube fabrication apparatus in bulletin No. 28 and tube couplings in bulletin No. 32 just issued by the Parker Appliance Co., 10320 Berea Road, Cleveland, Ohio.

IN THE OCTOBER issue of Nickel Cast Iron News, sent out by The International Nickel Co., 67 Wall St., New York City, is an article on Walworth Chrome Nickel Iron Pipe, its production and properties, also answers to questions as to the use of Ni-Resist. cast iron for chimney caps, grinding mill parts, stoker tuyeres and centrifugal pumps.

IN A PAMPHLET just issued by Combustion Engineering Corp., 200 Madison Ave., New York, the X-Ray method of testing welded joints, is discussed, and an installation of X-ray equipment which is representative of the latest development in this field is described.

PLASTIC BRICK, for boiler furnaces, bridge walls, baffles and all types of industrial furnaces, is described in a recent 6-page bulletin just issued by Oxford Plastic Brick Co., P. O. Box 422, Cambridge, Ohio.

SPLIT-STAGE low temperature refrigeration to produce very low temperatures by the use of both ammonia and CO_2 compressors in the same system is covered in bulletin 208-A just issued by the Frick Co., Waynesboro, Pa. This is a recent development in the refrigeration field and it is explained in considerable detail by means of diagrams, photographs and drawings.

Power Plant Construction News

Calif., San Francisco—California Carbonic Ice Mfg. Co., 200 Bush Street, is said to be planning installation of electric motors and other power equipment in proposed new ice-manufacturing plant at Third and Twenty-third Streets, entire project to cost over $200,000. C. A. Winder, address noted, is engineer.

Ill., Highwood—North Shore Sanitary District, Waukegan National Bank Building, Waukegan, Ill., plans installation of pumping machinery and other power equipment in connection with proposed extensions in sewage treatment plant at Highwood, entire project to cost close to $90,000. Pearse, Greeley & Hansen, 6 North Michigan Avenue, Chicago, are engineers.

Ind., Seymour—City Council is negotiating for purchase of property of Seymour Water Co., furnishing local service, for consideration of about $300,000, and contemplates extensions and improvements in plant and system.

Iowa, Mechanicsville—Iowa Railway & Light Co., Cedar Rapids, is said to be planning construction of a power substation at Mechanicsville, for commercial light and power service.

Iowa, Waterloo—Rath Packing Co., Sycamore and Elm Streets, plans installation of electric power equipment in four-story and basement addition to meat packing plant, estimated to cost $100,000, for which plans have been completed by H. P. Henschien, 59 East Van Buren Street, Chicago, Ill., engineer.

Kan., Mankato—City Council is said to be planning installation of pumping machinery and auxiliary equipment in connection with extensions in municipal waterworks, for which a bond issue of $60,000 has been authorized.

La., New Orleans—Mississippi Portland Cement Co., care of B. R. Alford, Canal Bank Building, engineer, recently organized by Andrew Fitzpatrick, Barrone Building, and associates, plans construction of a power plant at proposed new cement mill in Mississippi, entire project reported to cost over $500,000. Engineer noted is in charge.

Me., Ellsworth—Forest Products Co., Ellsworth, plans installation of electric motors and other power equipment in connection with proposed rebuilding of mill, recently destroyed by fire with loss reported at $25,000.

Md., Baltimore—Domestic Utilities Co., Garrison Avenue and Western Maryland Railroad, is said to have plans under way for rebuilding of cold storage and refrigerating plant, recently damaged by fire.

Mass., Cambridge—National Biscuit Co., 449 West Fourteenth Street, New York, plans installation of electric power equipment in proposed new baking plant on Cambridge Street, near Willow Street, Cambridge, reported to cost over $150,000.

Mass., Ipswich—Naumkeag Steam Cotton Co., Salem, Mass., operating Pequot textile mills, plans installation of electric power equipment in proposed new bleaching and finishing plant at Ipswich, entire project reported to cost over $80,000. Lockwood, Greene Engineers, Inc., 24 Federal Street, Boston, Mass., is engineer.

Mich., Marquette—Board of Public Works is said to be planning installation of pumping machinery and auxiliary equipment in connection with proposed extensions and improvements in municipal waterworks, reported to cost about $40,000. Pearse, Greeley & Hansen, 6 North Michigan Avenue, Chicago, Ill., are engineers.

Mich., East Lansing—Board of Trustees, Michigan State College, is planning installation of high pressure boiler, stoker and auxiliary equipment in power plant at institution, estimated to cost over $50,000. Engineering department of university is in charge.

Minn., Duluth—Duluth Steam Corporation, Duluth, has had plans approved by City Council for proposed new steam power plant on Commerce Street, estimated to cost over $1,000,000, with equipment, and will proceed with work at an early date. Sullivan & Orrfalt, Palladio Building, Duluth, are architects; Ralph Thomas, 1200 Second Avenue, South, Minneapolis, Minn., is mechanical engineer.

Miss., Columbus—City Council has preliminary plans under way for a municipal electric light and power plant, for which a bond issue of about $300,000, will be arranged. The Burns & McDonnell Engineering Co., Interstate Building, Kansas City, Mo., is engineer.

Mo., Princeton—City Council is said to be planning installation of pumping machinery and auxiliary equipment in connection with extensions and improvements in municipal waterworks. A bond issue of $35,000, has been approved. Charles A. Haskins, Finance Building, Kansas City, Mo., is engineer.

Mont., Forsyth—Mountain States Power Co., Casper, Wyo., has approved plans for the construction of a transmission line for service at Forsyth, Sanders, Howard and vicinity, reported to cost about $50,000. Company engineering department is in charge.

Nev., Reno—Union Ice Co. has filed plans for an addition to ice-manufacturing plant, to increase capacity from 35 to 60 tons a day, reported to cost about $40,000. H. K. Thompson is plant manager.

N. J., Manasquan—Manasquan Ice Block & Storage Co., Manasquan, is planning rebuilding of portion of boiler plant and refrigerating works, recently destroyed by fire with loss of about $60,000.

N. Y., Bingham—Matthews Oil Corporation, Bingham, near Bradford, Pa., plans rebuilding of water pressure and air pressure plants at local oil properties, recently destroyed by fire with loss reported at $30,000.

N. Y., Hemlock—Livingston County Canning Co., Hemlock, plans installation of electric power equipment in connection with proposed rebuilding of portion of food canning plant, recently destroyed by fire with loss over $100,000.

N. Y., Sparta—New York Central Electric Corporation, Hornell, N. Y., has secured permission to construct and operate an artificial gas plant at Sparta, reported to cost over $90,000. Engineering department is in charge.

N. C., Charlotte—Piedmont Cold Storage Corporation, Law Building, Granger Pierce, head, has approved plans for a one-story cold storage and refrigerating plant, reported to cost about $35,000, with equipment.

N. C., Greensboro—Swift & Co., Union Stock Yards, Chicago, Ill., has purchased a site on Tomlinson Street, Greensboro, and is said to be planning early construction of a cold storage and refrigerating plant to cost over $100,000.

N. C., Kannapolis—Cannon Mills Co., Kannapolis, is said to be planning installation of electric motors and other power equipment in proposed addition to textile mill, entire project to cost $75,000.

Ohio, Cincinnati—Early & Daniel Co., 6 East Fourth Street, is said to be planning installation of electric power equipment in connection with proposed rebuilding of grain elevator, recently destroyed by fire with loss over $100,000.

Ohio, Columbus—Department of Public Welfare, Ninth and Oak Streets, has rejected bids recently received for steam generating units and auxiliary equipment for power house at penitentiary. New bids will be asked at early date. C. E. Morrow, Division of Engineering, State House, is engineer.

Ohio, Rocky River—Village Council is said to be planning installation of pumping machinery and other power equipment in connection with a sewage disposal plant to cost $105,000, for which plans have been completed by C. W. Courtney Engineering Co., 1770 East Eleventh Street, Cleveland, Ohio, engineer.

Pa., Philadelphia—Abbotts Aldernay Dairies, Inc., Thirtieth and Chestnut Streets, has filed plans for a one-story engine plant addition, reported to cost over $20,000 with steam equipment.

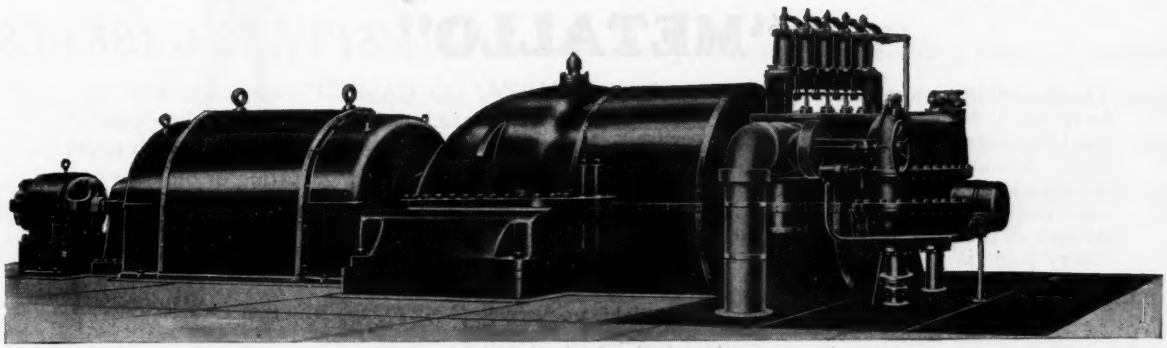
Texas, Dallas—Board of Public Works, O. H. Koch, director, plans installation of pumping machinery and other power equipment in proposed new sewage disposal plant, estimated to cost about $1,500,000. Hawley, Freese & Nichols, Fort Worth, Texas, are consulting engineers.

Texas, Jasper—Evans Products Co., Union Trust Building, Detroit, Mich., plans installation of electric power equipment in new wooden box and crate manufacturing plant at Jasper, entire project reported to cost close to $100,000. A boiler house is planned. E. S. Evans is president.

Texas, Taylor—Board of City Development has made recommendations to City Commission to construct and operate a municipal electric light and power plant.

Va., Charlottesville—Charlottesville Woolen Mills Co. plans installation of electric motors and other power equipment in proposed new four-story addition to textile mill, reported to cost over $85,000. Lockwood, Greene Engineers, Inc., 100 East Forty-second Street, New York, is engineer.

From throttle to exciter . . . it's ELLIOTT . . .



ELLIOTT BUILDS engine-driven as well as turbine-driven generator sets. The complete equipment — prime mover as well as generator—is of Elliott manufacture, built, assembled, and tested as a unit before it leaves the Elliott shops. Turbine or engine, and generator are built for each other, to team up together in perfect balance. The undivided responsibility resulting from this policy assures the user of entire satisfaction in the performance of the unit.

SOUNDLY engineered, designed and constructed along the most modern of lines for economy and reliability, the turbine-generator set illustrated above is typical of the Elliott line of similar equipment in capacities from 750 kw. to 5,000 kw.

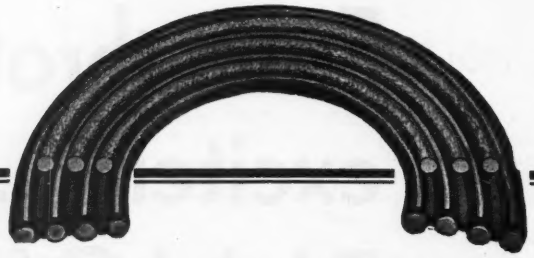
The turbine is equipped with five governor-operated steam admission valves, enabling excellent economy to be obtained over a wide range of loads. Each of these valves is separately actuated by an oil power cylinder—positive control for each valve. The governor is of the oil-operated type with a primary oil power cylinder to control the valve linkage. This governor is powerful and insures close speed regulation under varying load conditions.

Special provision has been made for taking care of both axial and lateral expansion in the turbine. A typical Elliott feature is the four-bearing construction. Turbine, generator and exciter each have two bearings, with flexible couplings between turbine and generator and generator and exciter.

Complete details are available at every Elliott office.

ELLIOTT COMPANY
PITTSBURGH, PA.
Steam Turbine Department • JEANNETTE, PA.
District Offices in Principal Cities

H-567



Make Up Your Mind—To Stand For NO MORE LEAKY PIPE JOINTS

Use —"METALLO" *STYLE 2 GASKETS*

These combination metal and asbestos gaskets have extra deep corrugations between which the long fiber asbestos cord rings are securely held. Unsurpassed in resiliency — there is plenty of spring for the gaskets to come back and maintain continuous contact with the flanges as the pipe line expands and contracts. Every joint is tightly sealed under all conditions.

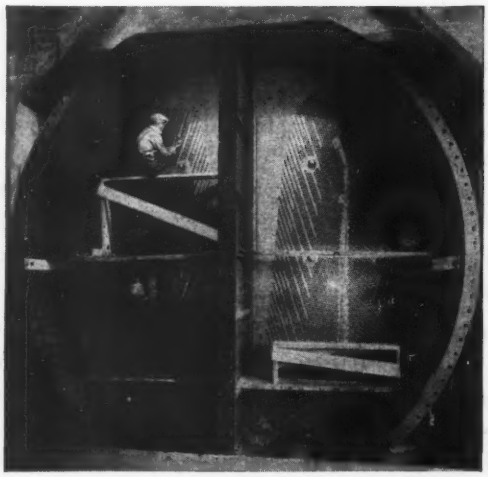
METALLO GASKETS are made with copper, bronze, steel, Monel metal, aluminum or alloys according to the service. There is never any danger of burning, rotting or blowing out.

A 90 days' free trial is the most convincing proof of our faith in their performance. Consult us on your gasket requirements.

To keep your Jenkins type valves tight, we recommend METALLO DISCS, made of copper sheathed asbestos with round or square hole. Use them on your radiator valves. There is nothing better for lasting tightness.

Metallo Gasket Company, New Brunswick, N. J.

CUT Condenser Maintenance



Over 50 Installations for Ford Motor Company

This latest installation of "JOHN CRANE" Endless Metallic Condenser Packing in the Ford Motor Co. Power House No. 1 on a 110,000-kw. Turbo Generator Condenser is genuine tribute to the efficiency of this packing.

Recommendations and estimates gladly supplied on request.

CRANE PACKING COMPANY

1802 Cuyler Ave., Chicago

New York—75 West St., Philadelphia—103 Walnut St., Pittsburgh—99 Vandergrift Bldg. Detroit—1720 Twelfth St., St. Louis—7306 Stanford Ave., San Francisco—112 Ninth St.

Increase Efficiency, with

"John Crane"

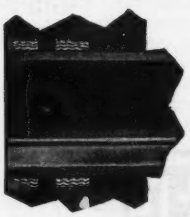
Condenser Tube Packing

No Ferrules

Large savings in material and labor are effected with the "JOHN CRANE" method of packing condensers without ferrules. "JOHN CRANE" endless metallic rings are unaffected by heat or polluted cooling waters and outlast old style packings by many years. Tubes remain tight and condensers operate as distillers.

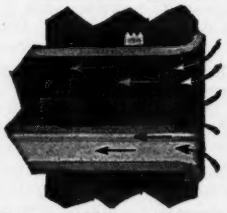
The efficiency of the steam plant depends to a very high degree upon the reliability of the condenser. That is why the largest and most economically operated plants throughout the world have adopted "JOHN CRANE".

Pack the Outflow



Outlet end packed with "JOHN CRANE" endless metallic rings, separated by fiber spacers. No ferrules. Tubes expand and contract freely. No unequal stresses.

Bell the Inflow



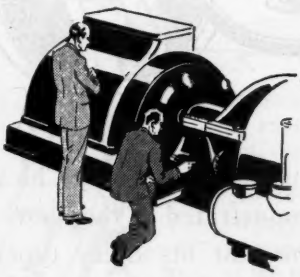
Inlet end belled over "JOHN CRANE" lead slugged fiber bushing and fixed. Perfect bonding. Improved flow lines. Turbulence reduced. Collection of debris reduced. Easier cleaning of tubes.

Free service from 45 lubrication experts

To help power plants in the middle west cut costs . .

PERHAPS you have already checked your operating costs . . . reducing expenses at every point possible. But are you sure you have caught every hidden saving? What about lubrication? Many power plants after making substantial savings, have found additional economies through the services of our lubrication engineers.

The power plant of a large manufacturing company, for example, has saved 1,374 gallons of Turbine oil in eighteen months through the recommendation of one of our lubrication engineers. A central station has further reduced lubrication costs 22% and a paper manufacturer has reduced lubrication costs 70%.



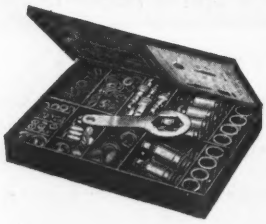
The Standard Oil Company (Indiana) makes it easy for power plants in the Middle West to secure the most effective and economical lubrication. Expert lubrication engineers are maintained at its various offices. There are forty-five of these lubrication experts who lend their services, without cost, to power plants to help reduce lubrication costs and increase lubrication efficiency.

This free service is offered to you—at any time, without obligation. Just ask our nearest office to send a lubrication engineer.

STANDARD OIL COMPANY
(Indiana)
910 South Michigan Avenue (1312) Chicago, Illinois

ONE UNIT

ONE KIT

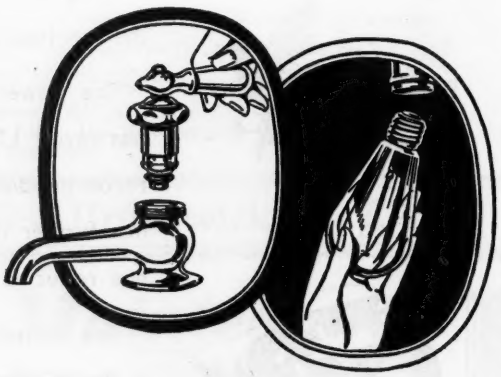


ONE RESULT

OK

"We have been using Chicago Faucets for replacements for about five years and we are glad to say that they have given very good service. We can safely say that when we have repaired one of your faucets, it is as good as new. We like the standardized, one unit idea, also the one-minute repair kit with which any faucet can be taken care of on an instant's notice. We find that the maintenance cost is very low, and with chromium finish, the faucets should have an indefinite life. We heartily recommend Chicago Faucets in every respect."

(Signed) M. E. Sears,
Maintenance Engineer,
Railway Exchange, Chicago.



The simplicity of construction in every Chicago Faucet is clearly demonstrated in the above illustration. The same unit fits every type of faucet—on sinks, lavatories, etc. The only two wearing parts are on the bottom of the unit—the seat and washer. Replacing them costs but a few cents and is as easy as changing a light bulb.

Lower your maintenance costs to the minimum in 1932 by using Chicago Faucets.

The Chicago Faucet Company
2700-22 N. Crawford Avenue, Chicago

CHICAGO FAUCETS

"A steam trap good enough to stand a fire is good enough to standardize on"

AN Armstrong inverted-bucket steam trap that had gone through a paper mill fire was salvaged by another user of steam equipment. After putting in a new gasket, the trap worked and still continues to work perfectly.

The above case, and other thousands of installations where Armstrongs have operated efficiently for years without attention, show why executives in practically all steam-using industries say: "this is the trap to standardize on." One of the more recent converts to Armstrong traps is an Eastern railroad system, which standardized on this trap after extensive tests on all makes. A number of companies have over a thousand Armstrongs in service. There are more of them in use than any other mechanically operated trap.

Cost records of a large soap manufacturer give the Armstrong the lowest maintenance cost per trap annually of any trap installed in their works. Likewise maintenance records kept by one of the largest industrial plants justified replacing all other makes of steam traps with Armstrongs. Decreased maintenance cost paid for the Armstrongs in less than three years; after that time they returned a very handsome profit on the investment.

You probably have some Armstrongs in use already. If not, we will gladly send you as many as desired for 90 days' free trial, also an interesting booklet on the principles and economies of steam trapping.

ARMSTRONG MACHINE WORKS

810 Maple Street, Three Rivers, Mich.

Stocks in all principal cities

PPE 12-15 Gray

Sizes:
¾" to 2".

This Is Bundy Junior

The Last Word In Power, Capacity, Efficiency, Endurance, Ease of Part Replacement, Low First and Final Cost.

A Non-Air-Binding Separating and Flood Trap for High Pressure and Vacuum that has had grilling service tests in hundreds of plants and come through them successfully.

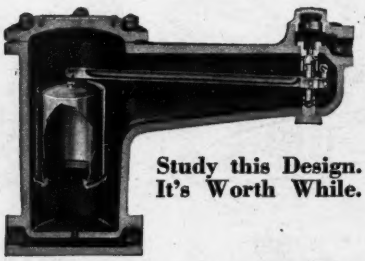
Write right now for Bundy Junior Details, the proof of our claims.

●

Greater Leverage gives it greater capacities. **All Parts Renewable without disturbing connections**

The Biggest Money's Worth of Trap

by comparison of weights and capacities per dollar of cost, or any other way you want to figure.



Study this Design. It's Worth While.

BUNDY STEAM TRAP COMPANY

NASHUA, N. H., U. S. A.

Representatives in all principal cities.

The Old Reliable Type "B" Separator

For thirty-two years the *Wright-Austin Type "B" Separator* has "stood the racket" and is still without an equal. Moderate in price, efficient in operation (removing moisture down to ½ of 1%), cast in one piece, effective under all ordinary conditions, they are a product of which to be proud.

Send for Bulletin 703

Wright Austin Co., Detroit

315 West Woodbridge St.

don't buy

STEAM TRAPS

UNTIL YOU HAVE INVESTIGATED THE

K-MASTER

TRADE MARK

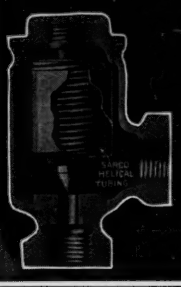
MODERNIZED INVERTED BUCKET TYPE STEAM TRAP

The trap that permits changing or reversing valve and seat in less than two minutes. All valve assembly joints are visible, eliminating concealed steam leaks. . . . Quick in its valve action. No wire drawing. . . . cannot air bind. . . . No steam blowing. Stainless steel valve and linkage. Economical in operation. Fool proof and efficient in maintenance. ECONOMIZE WITH K-MASTER.

KAYE & MACDONALD, INC.
96 Franklin Avenue
WEST ORANGE,
NEW JERSEY

NO CHANCE FOR CONCEALED LEAKS

SARCO
STEAM TRAP



Simply screw the Sarco Steam Trap into your pipe-line. It is self-adjusting for pressures from 0 to 100 lbs. That saves time. Saves work.

It drains all condensation as soon as formed. Doesn't leak—doesn't waste steam. Cannot air bind.

It costs about one-third the price of big bucket or float traps. Sold on 30 days' free trial. Booklet B-95 on request.

SARCO CO., INC.
183 Madison Ave., New York City
Branches in Principal Cities

Centrifix

Internal Purifiers for Steam Boilers—line purifiers for steam, gas or air—efficiencies to 100%—moderate cost.

Eliminates troubles from scale, dirt, oil, wet steam—prevents priming, slugging—increases superheater temperature.

Write for Complete Information

CENTRIFIX CORPORATION, 3029 Prospect Ave. CLEVELAND, O.

PURIFYING EQUIPMENT FOR STEAM—VAPOR—GAS—AIR

$349.21 *in Three Months* from a $525 Investment

SOUTH WEST BOX COMPANY
SAND SPRINGS, OKLAHOMA

MOREHEAD MANUFACTURING COMPANY,
4505 GRAND RIVER AVE.,
DETROIT, MICHIGAN.

DATE OF INVOICES	AMOUNT OF INVOICES	DEDUCTIONS		
		FREIGHT	SUNDRY	MEMORANDUM
8/7	117.05			Savings made in fuel bill for month of July, 1931
TOTAL OF INVOICES LESS DEDUCTIONS	$ 117.05	CASH DISCOUNT	$	AMOUNT REMITTANCE	$ 117.05

To drain their steam-heated equipment and return condensate to the boiler, South West Box Company, Sand Springs, Oklahoma, last June bought a Morehead-Back-to-Boiler System—for $525.00.

The above remittance memo shows that in July, $117.05 in fuel alone was saved as a result of this Morehead installation.

Fuel saving in August was $101.65—in September $130.51.

With Morehead equipment, you can make important savings in your own plant.

Get the facts. Send for our interesting 44-page booklet.

MOREHEAD MANUFACTURING COMPANY
DEPARTMENT PE - DETROIT, MICHIGAN

Morehead
Back to Boiler
SYSTEM

COUPON

Morehead Mfg. Co.,
Department PE
Detroit, Michigan

I'd like to have your interesting 44-page booklet, giving helpful information regarding the Morehead Back-to-Boiler System. This will, of course, place me under no obligation.

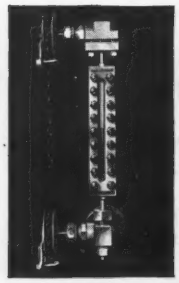
Name_____

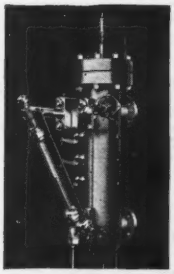
Company_____

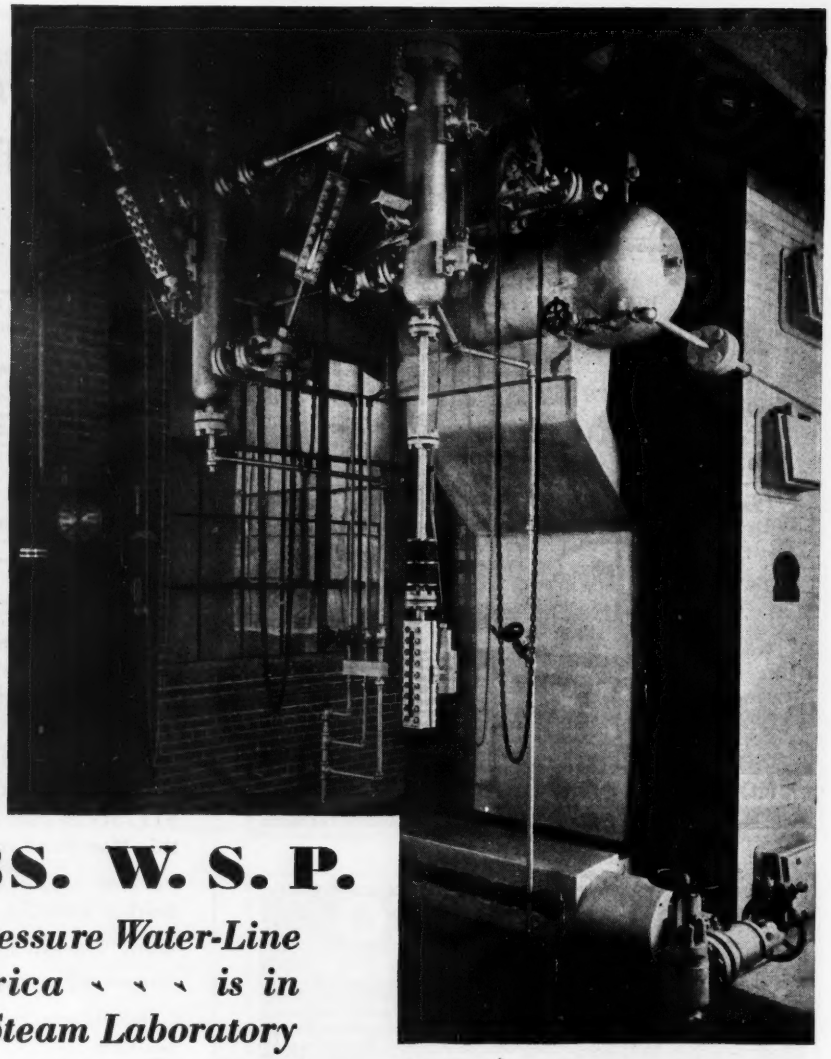
Address_____

City_____ State_____

(489)







2,500 LBS. W. S. P.

The Highest Pressure Water-Line Boiler in America . . . is in Yarway's New Steam Laboratory

Yarway leads again with a notable addition to the facilities which insure the user of Yarway Products superior service, long life, freedom from trouble and expense.

With over ten thousand installations of Yarway steam service equipment throughout the world, including over 80% of all the high pressure plants in existence, Yarway has always felt it an obligation not only to keep pace with the times, but to constantly forge ahead with new developments in anticipation of mounting pressures, and temperatures — to meet every new and more strenuous service requirement with tried and proven equipment.

Hence, it is with real satisfaction that they announce this new steam laboratory—for it will be a proving ground such as has never before been approached for the testing of present Yarway Products, under conditions duplicating all working conditions and service requirements. And in addition, it will provide the means for invaluable research into the realm of higher working steam pressures than have yet been encountered, commercially.

Are you familiar with the complete line of Yarway Products? All are worthy companions to the famous Seatless Blow-Off Valve. All are backed by the same 25 years of experience in power plant operation problems. All are results of the same sound, forward-thinking, engineering minds. Investigate.

YARNALL-WARING COMPANY
Mermaid Street Philadelphia

Principal YARWAY Products

SEATLESS BLOW-OFF VALVES
•
DOUBLE-TIGHTENING BLOW-OFF VALVES
•
FLOATLESS HI-LO ALARM WATER COLUMNS
•
SE-SURE INCLINED WATER GAGES
•
WATER GAGE ILLUMINATORS
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INVOLUTE SPRAY NOZZLES
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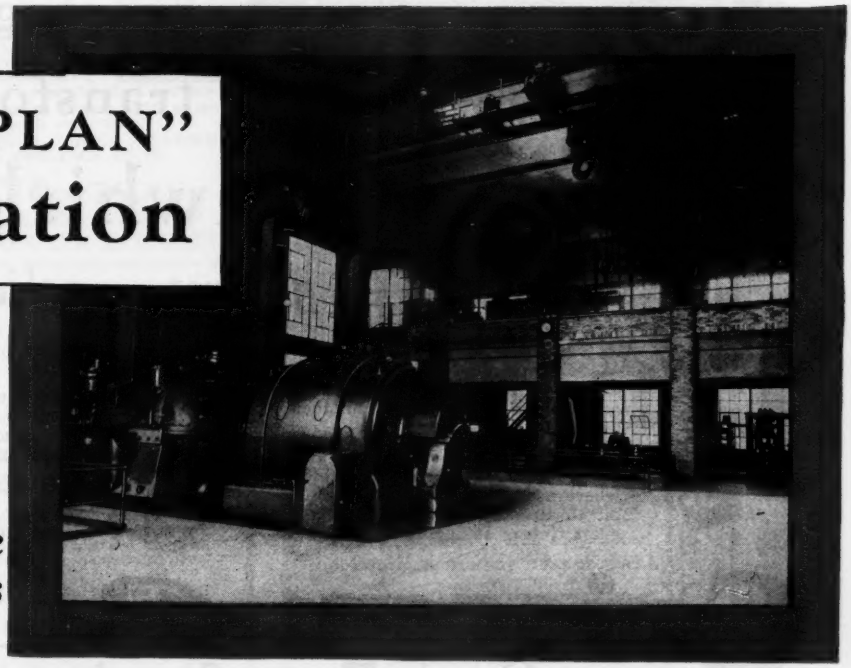
CYLINDER-GUIDED EXPANSION JOINTS

YARWAY

INVESTIGATE

"UNIT PLAN" Lubrication



...to increase your profits

Let our engineers discuss with you how you can speed production and cut operating costs with a complete lubrication plan specifying the proper oils refined from the proper crudes.

Earnings sheets at the end of the year can be improved by better lubrication. Plant managers who have adopted Cities Service "Unit Plan" of Lubrication have found this out. Let us talk to you about it... give you figures ...tell you just what Cities Service lubrication engineers can do to increase your plant's efficiency and cut your operating costs.

Cities Service affords widest choice of crude oils, including Pennsylvania, for any special lubricating job ... so, no matter what your problem is, let our engineers discuss it with you.

We'll provide plans for plants of every size and kind including all types of machinery from smallest lathe to giant turbine. Our engineers can be of saving service to you. Find out how—today. Just mail coupon below.

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ONCE - ALWAYS

CITIES SERVICE RADIO CONCERTS, Fridays, 8 P.M. Eastern Standard Time—WEAF and 37 Stations on N.B.C. Nation-Wide Network.

CITIES SERVICE COMPANY
60 Wall Street, New York, N.Y.
We are interested in your "Unit Plan" of Lubrication.

We operate.....machines.
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Our products are.....
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Name.....
Street.....
City.....*State*.....

CITIES SERVICE
INDUSTRIAL OILS
QUALITY PROVED WHERE IT SHOULD BE PROVED — IN INDUSTRIAL USE

For Cooling—

bearing oil

transformer oil

The G-R Multiwhirl Cooler

compact — efficient — reliable

THE G-R Multiwhirl Cooler is being used in thousands of installations where hot water, oil or other liquid is cooled by another liquid.

It reduces lubricating oil bills and promotes better bearing service where used to cool the lubricating oil to turbine bearings, reduction gears, etc. It permits carrying greater loads in safety on transformer oil cooling service.

The special features, advantages and many applications of the G-R Multiwhirl Cooler are fully described in bulletin which will be sent on request.

The Griscom-Russell Company
285 Madison Ave., New York
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Griscom-Russell
Heat Transfer Apparatus

LOWERED MAINTENANCE COSTS

The "honest" body and unchanging density of Keystone Grease will not only keep your equipment "geared up" to highest productivity—it will actually save you money. Let us *prove* it to you.

KEYSTONE GREASE

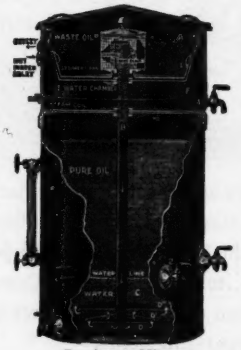
Keystone Lubricating Company, 21st, Clearfield & Lippincott Streets, Philadelphia, Penna., Est. 1884.

KEYSTONE LUBRICANTS

5 MINUTES

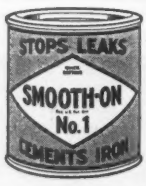
is all the time required to clean an American Oil Filter. Its operation is simple and the results are highly effective. Write today for our latest catalog.

THE BURT MFG. CO.
44 E. South St., Akron, O.



Sectional View American Oil Filter

Keep a supply of SMOOTH-ON handy



WITH these two grades of Smooth-On (Nos. 1 and 3) you are properly prepared to make tight new, and stop leaks in old joints, patch cracks in pressure parts, and do a perfect job with least effort.

Write for free copy of Smooth-On Repair Book.

Get Smooth-On in 1 or 5-lb. cans or larger kegs from your dealer or from us.

SMOOTH-ON MFG. CO.
Dept. 31, Jersey City, N. J.

Do it with **SMOOTH-ON**

DE LAVAL OIL PURIFIER

keeps oil clean and dry . . . indefinitely maintains its original lubricating qualities . . . assures utmost bearing protection at minimum cost. Used by 95% of America's greatest electric power systems.

Bulletin 106-Z.

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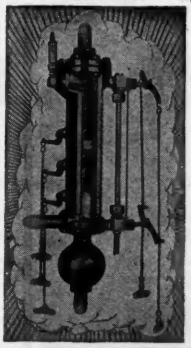
Depend upon 47 Years of Reliance Dependability



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SAFETY WATER COLUMNS

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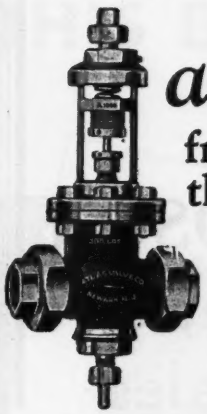

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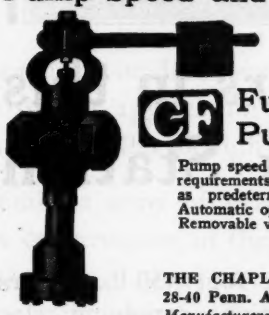

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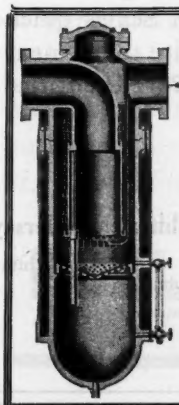

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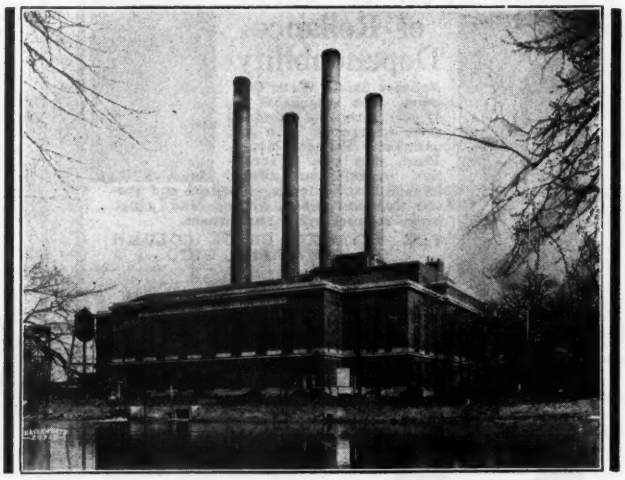
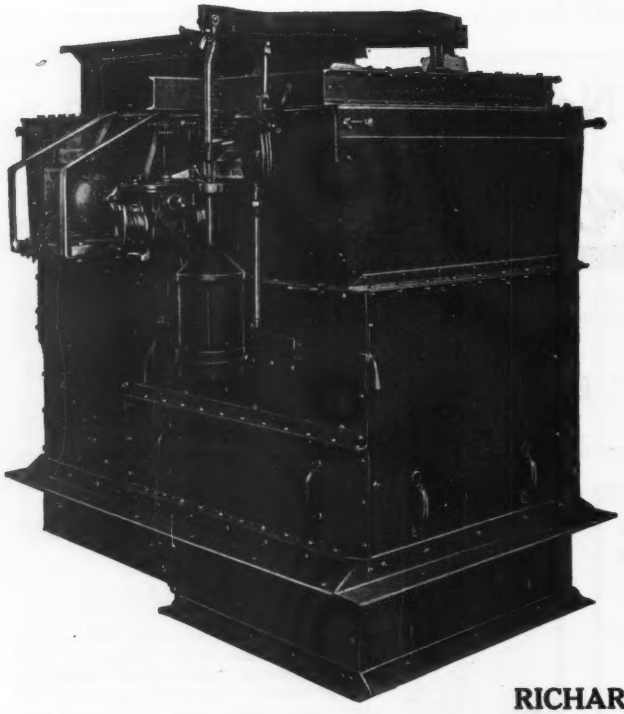
Moores Park Station, Lansing, Michigan . . . Consulting Engineer, J. E. Woodwell.



8 RICHARDSON Automatic Coal Scales protect *fuel dollars* in this new Moores Park Station



Each of the four 450-lb. boilers at this new station, supplying electric energy for the municipal system of Lansing, Michigan, is equipped with two Richardson Scales for weighing coal direct to stokers.

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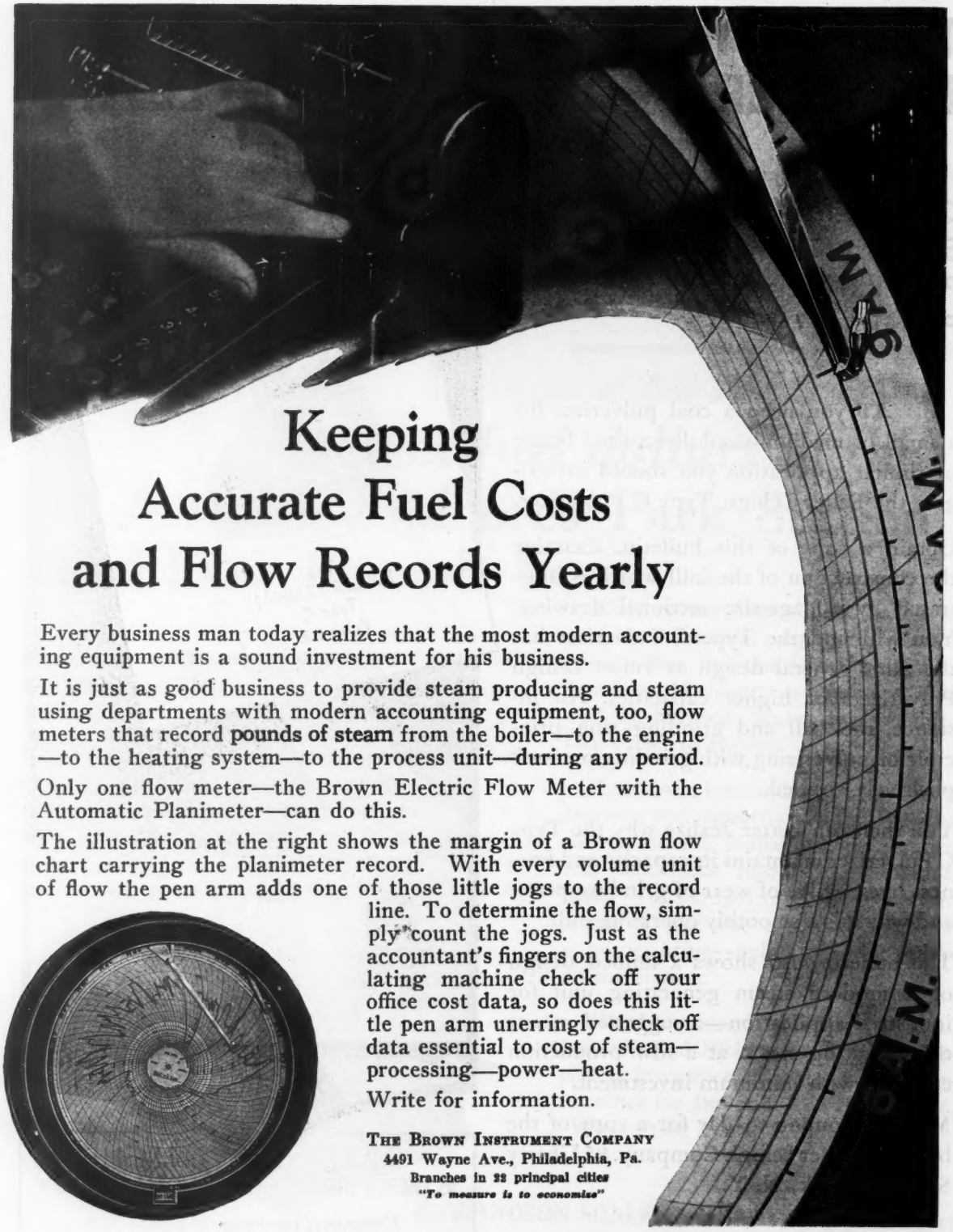

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Every business man today realizes that the most modern accounting equipment is a sound investment for his business.

It is just as good business to provide steam producing and steam using departments with modern accounting equipment, too, flow meters that record **pounds of steam** from the boiler—to the engine —to the heating system—to the process unit—during any period.

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The illustration at the right shows the margin of a Brown flow chart carrying the planimeter record. With every volume unit of flow the pen arm adds one of those little jogs to the record line. To determine the flow, simply count the jogs. Just as the accountant's fingers on the calculating machine check off your office cost data, so does this little pen arm unerringly check off data essential to cost of steam—processing—power—heat.

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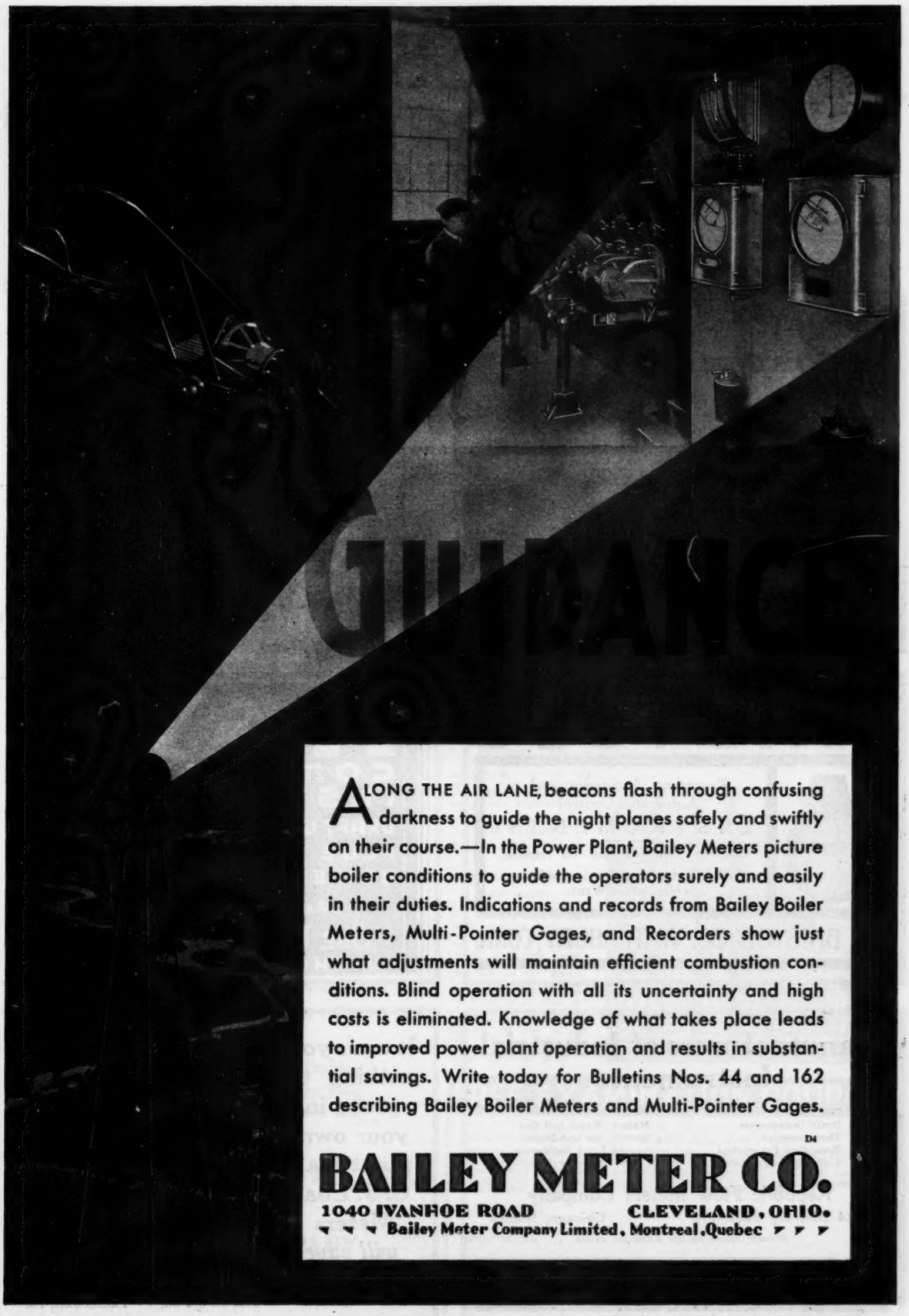

ALONG THE AIR LANE, beacons flash through confusing darkness to guide the night planes safely and swiftly on their course.—In the Power Plant, Bailey Meters picture boiler conditions to guide the operators surely and easily in their duties. Indications and records from Bailey Boiler Meters, Multi-Pointer Gages, and Recorders show just what adjustments will maintain efficient combustion conditions. Blind operation with all its uncertainty and high costs is eliminated. Knowledge of what takes place leads to improved power plant operation and results in substantial savings. Write today for Bulletins Nos. 44 and 162 describing Bailey Boiler Meters and Multi-Pointer Gages.

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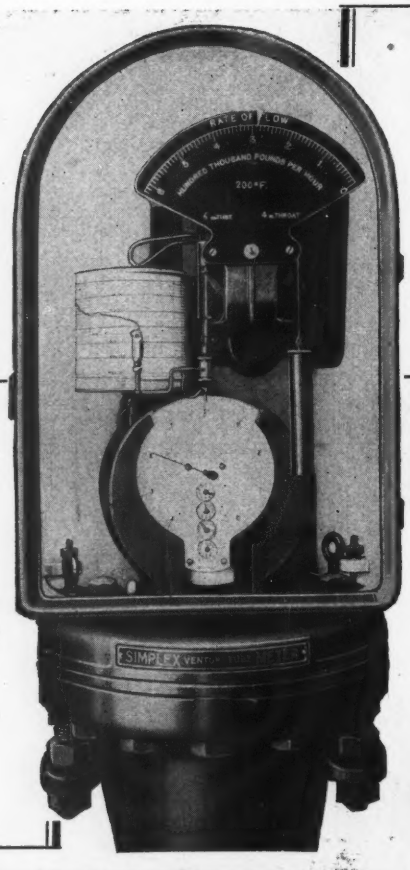

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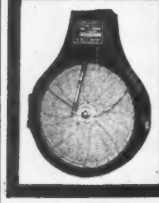

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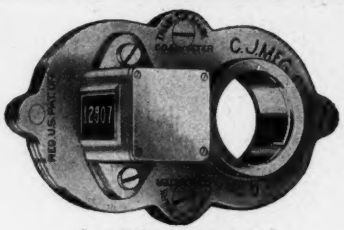

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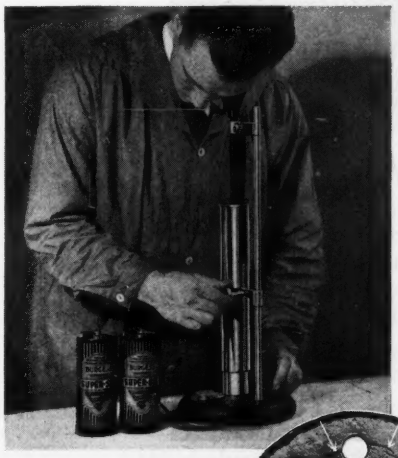

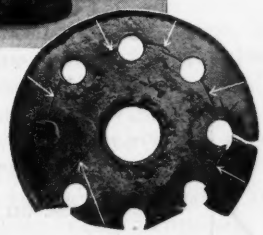

At right: Section of boiler plate showing cracks between rivet holes due to embrittlement. Above: Testing boiler water with Turbidimeter.

RIVERSIDE POWER MFG. CO., National Paper Co., Nestle's Milk Products, Inc., Mid-Continent Petroleum Corp., and many other concerns are finding the Burgess-Parr Turbidimeter invaluable in ending boiler embrittlement hazards.

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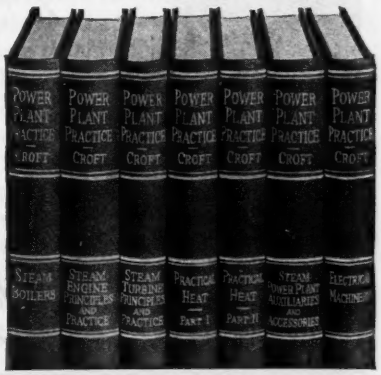

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The following comparisons of principal operating costs indicate some of the savings resulting from the changes:

Year	1926	1927	1928	1929	1930**	1931
Mill Products—Tons	19,700	19,600	20,400	21,000	20,200	...
Coal Burned—Tons	22,826	19,903	20,269	19,837	16,704	...
Power Plant Payroll—Men	30*	29*	28*	20	20	18
Hydro Power Water Cost	$26,379	$33,838	$39,276	$34,095	$34,358	...

*Note: Does not include men from yard gang for unloading coal.
**Note: First full year operating new boilers

This table shows primarily the results accomplished by the new boiler plant. The coal saving in dollars was in greater proportion than in tonnage, for a material reduction in cost per ton was possible through the ability of the new stokers to handle lower priced coal successfully.

The pictures show the power plant of the Champion-International Company and one of the new Taylor Stokers installed as part of its modernization program. The clipping reproduces part of an article by Marcus K. Bryan, of Charles T. Main, Inc., describing the changes that were made in the plant and the economies effected. A limited number of reprints of this article are available.

AMERICAN

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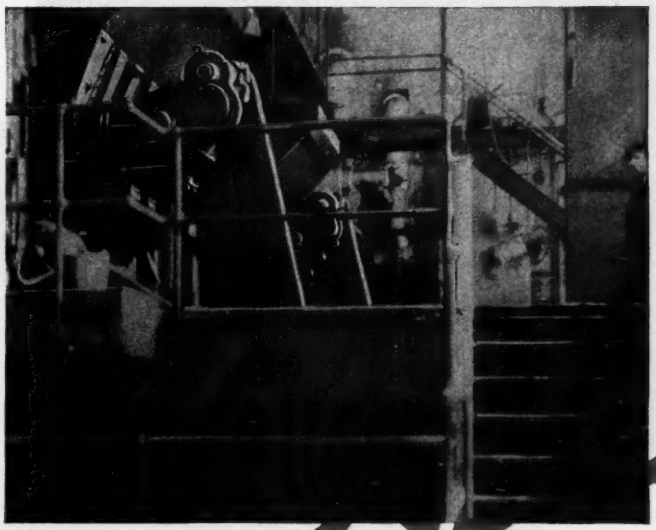
for the upswing of business with Taylor Stokers



The Champion-International Company, Lawrence, Mass., has completed a three-year program of plant modernization, including the installation of two new Taylor Stokers under 552 HP boilers. The new boiler plant, in its first year of operation, saved more than 3,000 tons of coal. Dollar savings are even greater in proportion, since the new stokers make it possible to use lower priced coal successfully. There was also a saving of about 33⅓% in the power plant payroll.

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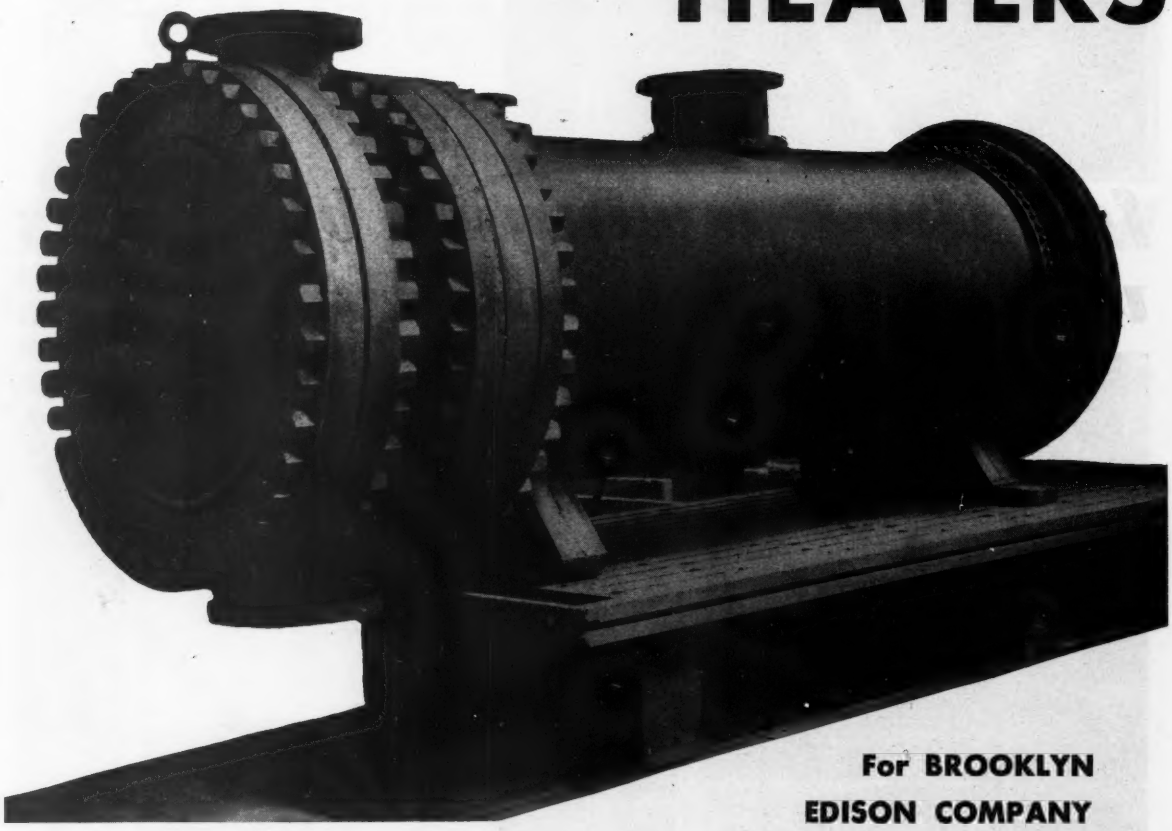

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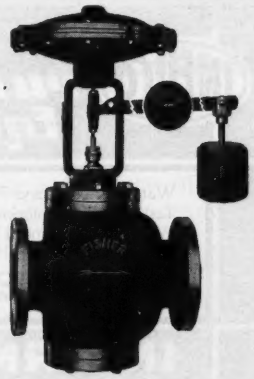

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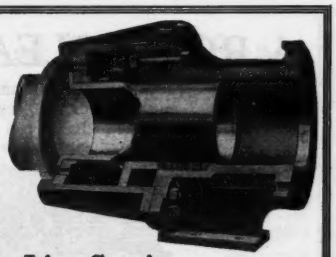

For Pipe Line Service

Eliminates trouble from Expansion and Contraction, saves space, labor and repair bills; the construction is mechanically correct.

ALBERGER HEATER CO.
HOWARD IRON WORKS
285 Chicago St.
Buffalo, N. Y.

REMOVE SCALE MECHANICALLY *Without Removing* TUBES

- . . . . . removes scale from boilers and prevents further deposits from forming.
- It is mechanical—not chemical—in action. It contains an element that expands and cracks the scale from the metal, then forms a protective coat on the metal itself.
- More than ten thousand users over the United States have found it efficient and economical.

YOUR TRIAL SHIPMENT IS READY

Take advantage of our sixty-day trial offer. Use Brooks Boiler Metal Treatment in *your* boilers for sixty days under our guarantee. Prove to yourself that it is efficient and economical for you. Just ask for the guaranteed trial offer.

THE BROOKS OIL CO., Cleveland, Ohio

GUARANTEED BY BROOKS OIL CO.

WATER PURIFIED

for every industrial and domestic use

Water Softening Apparatus of every variety

Filters—pressure and gravity

Steel Tanks for air, gas and liquids

128 years old, founded 1802

Wm. B. Scaife & Sons Co. Main Office OAKMONT, PA.

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INFILCO

Water Purification Equipment

Water Softeners and Filters—Of Every Type and Size
Taste—Odor—Chlorine—Color—Iron Removal Plants
Wet and Dry Chemical Feeders—Proportioning Devices
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INTERNATIONAL FILTER CO.
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INTERNATIONAL

Boiler Water Conditioning

There's an Elgin System or Elgin Equipment that will Solve Every Boiler Water Problem:

Deconcentrators.
Deconcentrators with Heat exchangers.
Zeolite-Deconcentrator Combination.
Heat Exchangers.
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Zeolite-Heat Exchanger Combination.
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Elgin Softener Corporation
MANUFACTURERS
WATER CONDITIONING EQUIPMENT
ELGIN, ILLINOIS

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EST 1906

Get COCHRANE Advice

Up-to-date, reliable information on numerous boiler room subjects will be found in Cochrane publications, as for example:

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Steam Purifiers and Steam and Oil Separators	671-684
Softening Water to prevent Scale, Foaming and Embrittlement	689
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Cochrane representatives, located in principal cities, will upon request investigate your conditions and make recommendations.

COCHRANE CORPORATION
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"The fuel saving alone amounted to more than 20%"

30 years of "Know How"

"Bare metal was all that confronted us," adds the superintendent of city water works, after using the Hawk-Eye Compound that we had provided for badly scaled-up boilers. It costs you nothing to find out what Hawk-Eye will do in your plant. Write.

HAWK-EYE COMPOUND CO.
(Not Inc.)
Blue Island, Illinois

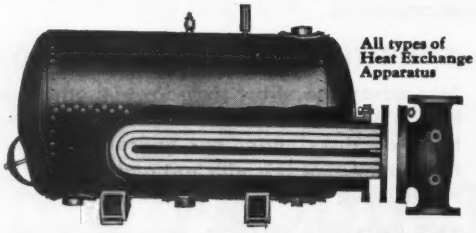
HAWK-EYE COMPOUNDS

HOPPES

— a complete line of feedwater heaters

Write for the details about Hoppes' money saving specialties. Feedwater heaters, Separators, Exhaust Heads, Oil Eliminators are described in Catalog 90. Shown here is a Hoppes Exhaust Steam Feedwater Heater with Steam Coils and Thermal Controls.

THE HOPPES MANUFACTURING CO., 70 Larch St., Springfield, O.



All types of Heat Exchange Apparatus

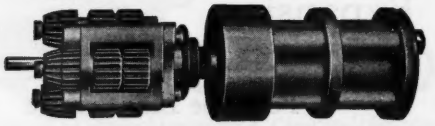
NATIONAL Red Head HEATERS

Improved flanged T cover gives unrestricted flow for entering steam. For Industrial plants, laundries, apartments, schools, clubs, hotels, etc. Send for Bulletin 68 and prices.

The National Pipe Bending Co., 160 River St., New Haven, Conn.
Boston · New York Philadelphia

A ROTO CLEANER

reduced the annual cleaning time for an eight-boiler battery from 28 to 18 days—enabled the seven clean boilers to carry the load and leave the eighth as a spare.



Roto Cleaners Can Be Furnished For Every Size and Type of Tube

THE ROTO COMPANY

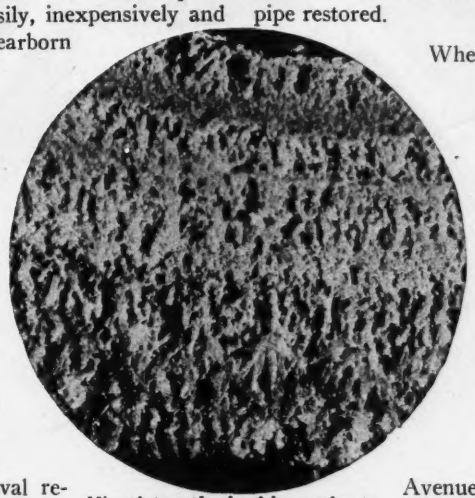
Sussex Ave. and Newark St., Newark, N. J.

Dearborn Special Formula No. 134

Removes Carbonate Scale from Any Equipment

Wherever carbonate scale reduces the efficiency of equipment, it can be removed easily, inexpensively and in a very short time with Dearborn Special Formula No. 134. (The removal of silicates and calcium sulphate is equally practicable with the correct Dearborn formulae.)

Engineers have relied on Dearborn Special Formula No. 134 for many years in this work because of its superior results. It is simply mixed with water and circulated through the equipment to be cleaned. In from one to three hours, an average scale deposit is removed completely. However, where the scale is very heavy, as sometimes occurs in water lines that are nearly closed, the removal requires a longer period. But as long as the line is not completely closed, the scale can be removed and the original capacity of the pipe restored.



Microphotograph of calcium carbonate scale, the dense formation deposited by direct precipitation and the more granular by mechanical attachment.

When the scale has all been disintegrated, it is drained off as a sludge and the equipment flushed clean.

Dearborn Special Formula No. 134 is recommended for cleaning feed lines, heaters, cooling coils, Diesel engine heads and jackets, condensers, pumps, evaporators, water meters, pasteurizers and boilers. Where practicable, a representative of this company will be present to assist in your first use of the formula. In any event, detailed instructions will be supplied. Inquiries invited. Address at 310 South Michigan Avenue, Chicago, 205 East 42nd Street, New York, or 2454 Dundas Street, West, Toronto.

DEARBORN CHEMICAL COMPANY

One *Thorough* Cleaning

WITH A

Dean

REG. U.S. PAT. OFF.

Universal Tube Cleaner

—will lead to greater savings than several jobs with other, less efficient, cleaning methods.

Test a Dean (without charge) and see why!

THE WM. B. PIERCE COMPANY

149 ELLICOTT ST. BUFFALO, N. Y.

DIAMOND SOOT BLOWERS

Please write for bulletin on boiler cleaning by modern methods.

DIAMOND POWER SPECIALTY CORPORATION-DETROIT

Get Off Coal Eating Scale

You can do so easily if you give the "Torpedo" a chance to work on your boiler tubes. All it wants is 2 to 4 hours—then the tubes will shine like new.

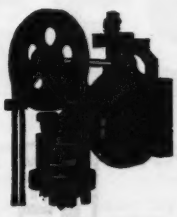
No hammering or pounding. The "Torpedo" taps evenly and lightly —11,000 taps a minute. The vibration so caused makes the hard and brittle scale crack and fall off. It cannot resist. No injury to tubes.

Just try a "Torpedo" once, and you'll never be without it afterwards. We'll send you one for a free trial if you'll write us.

The General Specialty Company, Inc.

70 Carroll St. Buffalo, N. Y.

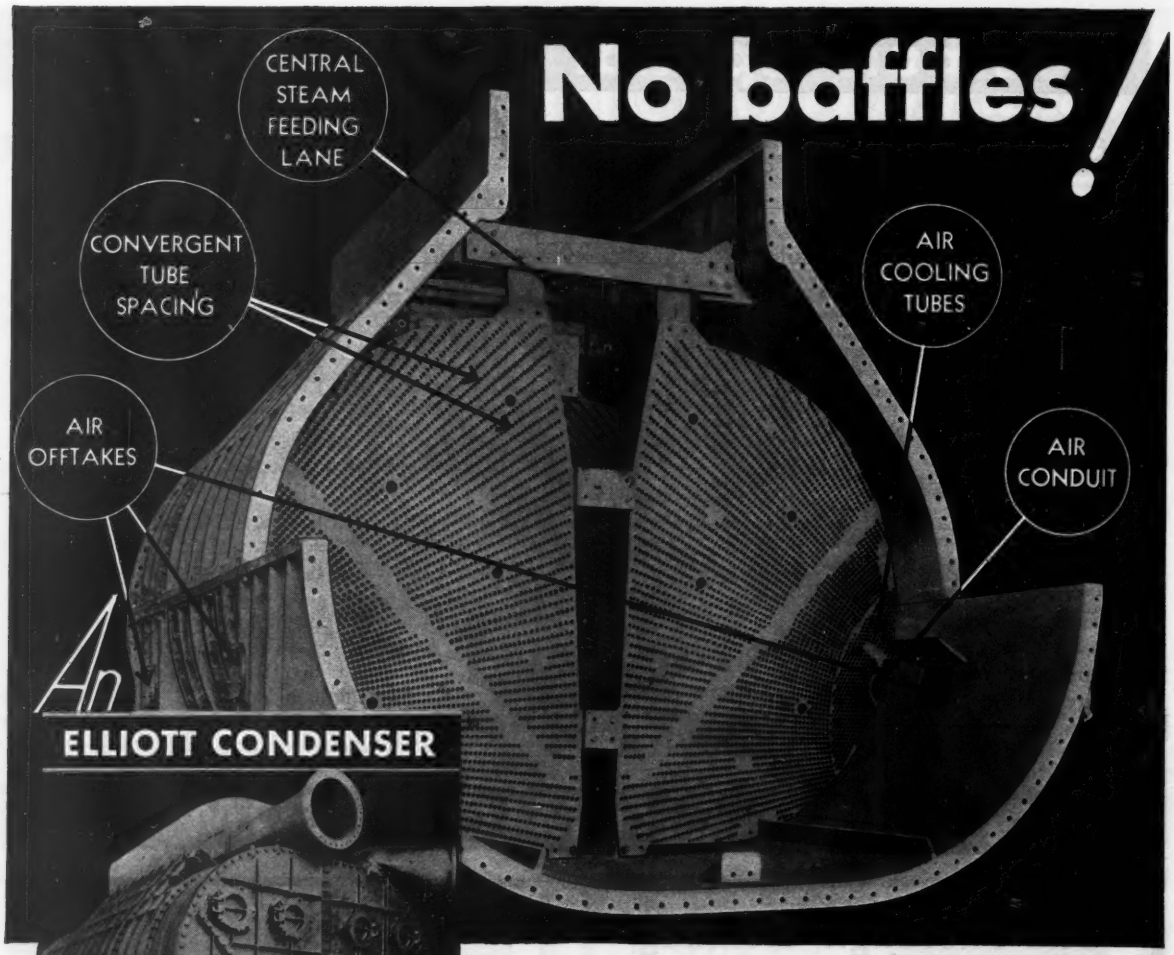
The BAYER SOOT BLOWER



The valve in the Bayer Master Model "K-2" opens wide before the element begins to rotate and remains wide open until after the element has stopped rotating. This means 100 per cent cleaning efficiency over the entire blowing arc. This feature is exclusively BAYER.

THE BAYER COMPANY

1506 South Grand Blvd. St. Louis, Mo.



Interior and exterior views of a 34,000-sq. ft. Elliott surface condenser furnished the Lincoln Wharf Station of the Boston Elevated Railway Company.

This condenser was designed for maximum condensing effect, low pressure drop, and hot deaerated condensate.

Of particular interest is the absence of baffles, and the straight-line flow to air offtakes, reducing internal resistance and increasing steam penetration.

This condenser is representative of all medium and large-sized units built by Elliott. As with all Elliott units, it is designed to fit the specific operating conditions governing its installation, and to obtain the highest possible economy from every angle. The "flexible" design of Elliott condensers permits of a wide range of modification in various respects, while at the same time retaining to the full the economies of the principles worked out and applied in scores of former installations.

Ask at our nearest district office for details of this interesting condenser design.

ELLIOTT COMPANY

PITTSBURGH, PA.

Condenser Department

JEANNETTE, PA.

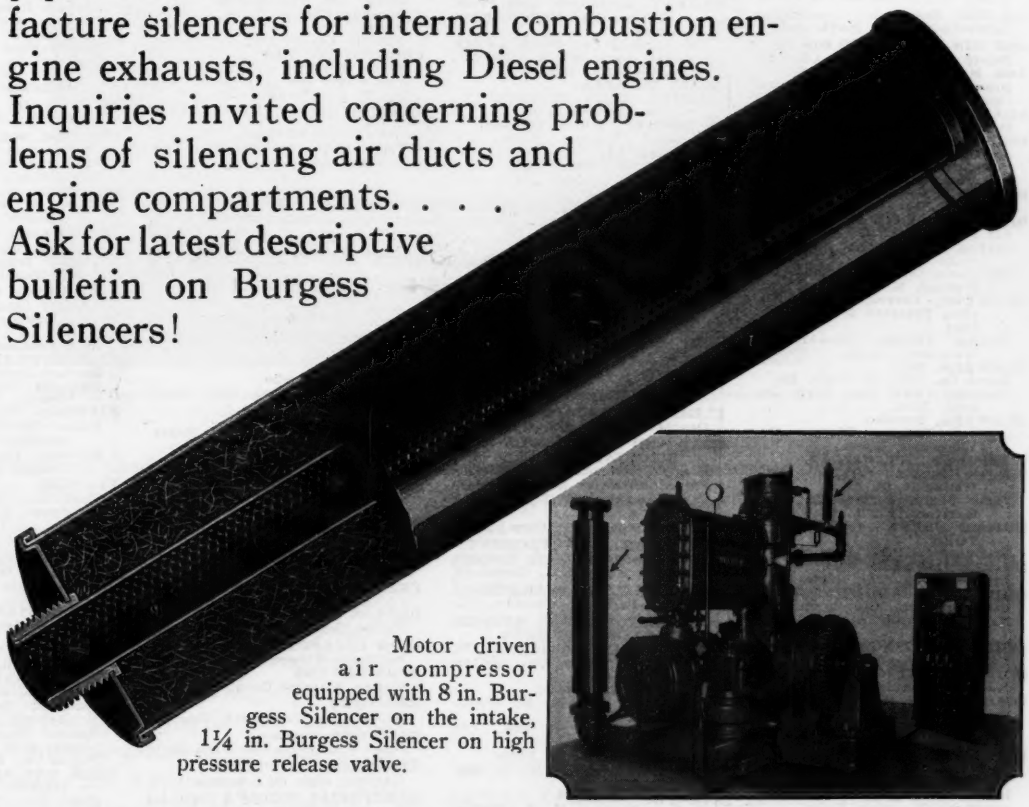
Branch Offices in Principal Cities

C-361a

Fit Air Compressor Intakes with BURGESS SILENCERS

They *absorb* noise—*save* power

Don't let old-style mufflers steal costly power. . . Equip your air compressors and blowers with Burgess Silencers . . . Their amazingly improved design permits a full unrestricted flow of air or gases—conserves power—cuts down operating costs. . . . Burgess Silencers fit all standard pipe sizes from 3/8 inch upward. We manufacture silencers for internal combustion engine exhausts, including Diesel engines. Inquiries invited concerning problems of silencing air ducts and engine compartments. . . . Ask for latest descriptive bulletin on Burgess Silencers!



Motor driven air compressor equipped with 8 in. Burgess Silencer on the intake, 1¼ in. Burgess Silencer on high pressure release valve.

BURGESS

ENGINEERS AND MANUFACTURERS OF ELECTRIC AND ACOUSTIC PRODUCTS

Mail Memo Today

BURGESS BATTERY COMPANY
Harris Trust Building, Chicago

We are interested in knowing more about Burgess Silencers and how they reduce costs. Send latest bulletin.

Name.....

Firm.....

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Machinery, Equipment and Supplies Used In The Production, Transmission and Utilization of Power

Under the heading of each product listed will be found the names of the manufacturers of that product. The index to advertisers, next to the back cover, gives the page numbers on which the manufacturers' descriptive advertisements appear

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Nash Engrg. Co., S. Norwalk.
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Edge Moor Iron Co., Edge Moor.

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Wright-Austin Co., Detroit, Mich.
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cisco, Calif.

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De Laval Steam Turbine Co., Trenton. N. J

BLOWERS, Forced Draft, Portable, Pressure & Pulverized Coal
Carling Turbine Blower Co., Worcester, Mass.

BLOWERS, Tube
Bayer Co., The, St. Louis, Mo.
Diamond Power Spec. Corp., Detroit, Mich.

BLOWERS, Turbine
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BOILER BAFFLES
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BOILER COMPOUNDS
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Hays Corp., Michigan City, Ind.

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Engineer Co., The, New York.

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Roto Co., The, Newark, N. J.

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Springfield Boiler Co., Springfield, Ill.
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BOILERS, Waste Heat
Edge Moor Iron Co., Edge Moor.
Wickes Boiler Co., Saginaw.

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Schubert-Christy Corp., Affton, Mo.

COUPLINGS, Flexible
Terry Steam Turbine Co., The, Hartford, Conn.

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Dearborn Chem. Co., Chicago.

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Fairbanks, Morse & Co., Chicago.

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Combustion Engrg. Corp., N. Y.

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Hays Corp., Michigan City, Ind.
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Republic Flow Meters Co., Chicago, Ill.

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Bailey Meter Co., Cleveland.
Engineer Co., New York, N. Y.

COMBUSTION ENGINEERS
Engineer Co., The, New York.

COMPOUND PIPE JOINT
Smooth-On Mfg. Co., Jersey City.

CONDENSER TUBE CLEANERS
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Pierce Co., Wm. B., Buffalo.
Roto Co., The, Newark, N. J.

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Dart Mfg. Co., E. M., Providence, R. I.

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Elliott Co., Jeannette, Pa.

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DESUPERHEATERS
Elliott Co., Jeannette, Pa.

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Chicago Faucet Co., Chicago, Ill.

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Fuller Lehigh Co., New York.

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Northern Blower Co., Cleveland.

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Foster Wheeler Corp., N. Y.

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Foster Wheeler Corp., New York.
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Foster Wheeler Corp., New York.
Griscom-Russell Co., New York.
Hoppes Mfg. Co., Springfield, O.
International Filter Co., Chicago.
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Scaife & Sons Co., Wm. B., Oakmont, Pa.
Worthington Pump & Mach. Corp., New York.

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Griscom-Russell Co., New York.
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International Filter Co., Chicago.
Permutit Co., New York.
Scaife & Sons Co., Wm. B., Oakmont, Pa.

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International Filter Co., Chicago.
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Fisher Governor Co., Inc., Marshalltown, Ia.
Kennedy Valve Mfg. Co., The, Elmira, N. Y.

FLANGES
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Dravo-Doyle Co., Pittsburgh.
Tri-Lok Co., Pittsburgh.

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Brown Inst. Co., Phila., Pa.
Republic Flow Meters Co., Chicago, Ill.

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Diamond Power Spec. Corp., Detroit, Mich.
General Specialty Co., Buffalo.
Liberty Mfg. Co., Jeannette, Pa.
Pierce Co., Wm. B., Buffalo.

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Hays Corp., Michigan City, Ind.
Permutit Co., New York.

FURNACE FIRE OBSERVERS
Springfield Boiler Co., Springfield, Ill.

FURNACE SURFACES, Water Cooled
Foster Wheeler Corp., New York.
Fuller Lehigh Co., New York.

FURNACE WALLS
Combustion Engrg. Corp., N. Y.

GAS BURNERS
Peabody Engrg. Corp., N. Y.

GAS COLLECTORS
Hays Corp., Michigan City, Ind.

GAS PRODUCERS
Wellman Engrg. Co., Cleveland.

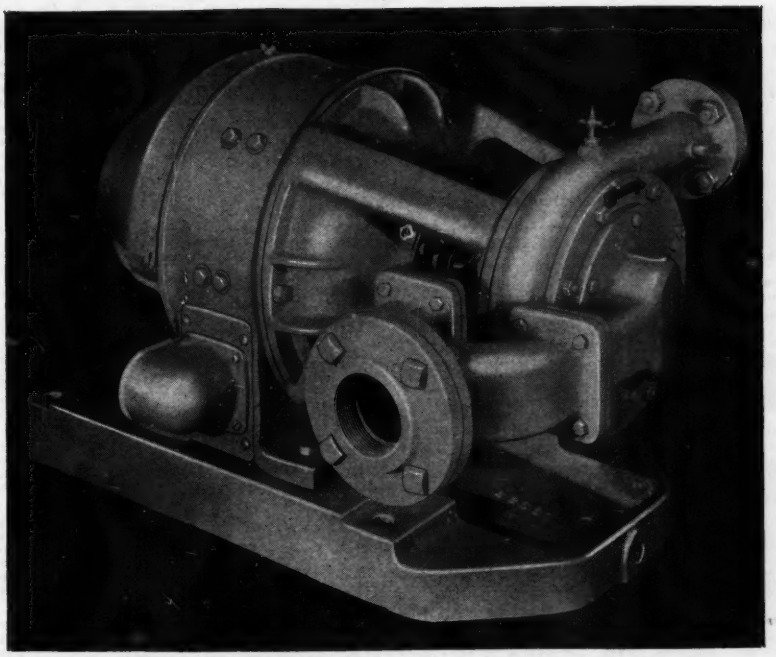
GASKETS
Metallo Gasket Co., New Brunswick, N. J.
Smooth-On Mfg. Co., Jersey City.

GAUGE COCKS
Reliance Gauge Column Co., Cleveland.

GAUGE GLASSES
Jenkins Bros., New York, N. Y.

THIS New Jennings Pump

is efficient, accessible, easy to install ...capacities up to 2000 g. p. m.



Jennings Centrifugal Pumps are furnished in single and double suction types with capacities up to 2000 g. p. m. Heads up to 300 ft. For complete information, write for Bulletin 155.

SKILLFUL design and precision manufacture assure unsurpassed efficiency in the Jennings Double-Suction Centrifugal Pump. Unit construction gives many advantages never before available in pumps with capacities up to 2000 g. p. m.

Pump and motor are one structure. The impeller is mounted on a short extension of the motor shaft. A rigid bracket, bolted to the motor housing, supports the pump casing. This bracket is integral with the motor end shield and is interchangeable on all motors of the same make and frame size. All bearings in the pump casing are eliminated. There is only one stuffing box.

When installing a Jennings Pump, no shaft alignment is necessary. Suction and discharge connections can be arranged in almost any desired position to conform to the piping layout. The number of fittings and the labor required are reduced to a minimum. The interior of the pump is easy to get at and the impeller can be removed for inspection or cleaning without disturbing packing, bearings or shaft alignment.

VACUUM PUMPS AND COMPRESSORS FOR AIR AND GAS ▪ RETURN LINE AND AIR LINE VACUUM STEAM HEATING PUMPS ▪ CONDENSATION PUMPS ▪ CENTRIFUGAL PUMPS ▪ SUCTION (SELF-PRIMING) CENTRIFUGAL PUMPS ▪ SUMP PUMPS ▪ SEWAGE PUMPS ▪ PNEUMATIC SEWAGE EJECTORS

NASH ENGINEERING COMPANY, 169 WILSON ROAD, SO. NORWALK, CONN.

Jennings Pumps

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Fisher Governor Co., Inc., Marshalltown, Ia.

GAUGES, Differential and U-Tube
Hays Corp., Michigan City, Ind.

GAUGES, Draft and Liquid Level
Bailey Meter Co., Cleveland, O.
Bristol Co., Waterbury.
Brown Inst. Co., Phila., Pa.
Hays Corp., Michigan City, Ind.
Pierce Co., Wm. B., Buffalo.
Republic Flow Meters Co., Chicago.

GAUGES, Pressure and Recording
Bristol Co., Waterbury.

GAUGES, Water
Reliance Gauge Column Co., Cleveland.

GEARS, Reduction and Double Helical
De Laval Steam Turbine Co., Trenton, N. J.
Moore Steam Turbine Corp., Wellsville, N. Y.
Terry Steam Turbine Co., The, Hartford, Conn.

GENERATING SETS
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Carling Turbine Blower Co., Worcester, Mass.
Fairbanks, Morse & Co., Chicago.
Moore Steam Turbine Corp., Wellsville, N. Y.
Terry Steam Turbine Co., Hartford, Conn.

GENERATORS, Electric
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Elliott Co., Ridgway, Pa.
General Elec. Co., Schenectady.

GOVERNORS, Compressor Unloader
Pickering Governor Co., Portland, Conn.

GOVERNORS, Engine
Pickering Governor Co., Portland, Conn.

GOVERNORS, Pump
Atlas Valve Co., Newark, N. J.
Chapin-Fulton Mfg. Co., The, Pittsburgh
Fisher Governor Co., Inc., Marshalltown, Ia.
Squires Co., C. E., Cleveland.
Wright-Austin Co.

GRATE BARS
Flynn & Emrich Co., Baltimore.

GRATES
Flynn & Emrich Co., Baltimore.
Kelly Foundry & Mach. Co., Goshen, Ind.
Neemes Fdry., Inc., Troy, N. Y.

GRATING, Steel
Dravo-Doyle Co., Pittsburgh.
Tri-Lok Co., Pittsburgh.

GREASE
Brooks Oil Co., Cleveland, O.
Cities Service Co., New York, N. Y.
Dearborn Chemical Co., Chicago.
Keystone Lubricating Co., Phila.
Standard Oil Co. (Indiana), Chicago, Ill.
Texas Co., The, New York.
Vacuum Oil Co., New York.

GREASE CUPS
(See Oil and Grease Cups.)

HEAT EXCHANGERS
Alco Products, Inc., New York, N. Y.
Elgin Softener Corp., Elgin, Ill.
Foster Wheeler Corp., New York.
Griscom-Russell Co., New York.
National Pipe Bending Co., New Haven, Conn.
Vogt Machine Co., Inc., Henry, Louisville, Ky.
Wheeler Mfg. Co., C. H., Phila.

HEATERS, Bleeder
Foster Wheeler Corp., New York.
Griscom-Russell Co., New York.

HEATERS FOR SPECIAL PURPOSES AND STORAGE
National Pipe Bending Co., New Haven, Conn.

HEATERS, Hot Water
Foster Wheeler Corp., New York.
Griscom-Russell Co., New York.
National Pipe Bending Co., New Haven, Conn.

HEATERS, Oil
Alco Products, Inc., New York, N. Y.
Hammel Oil Burning Equipment Co., Inc., Providence,
National Pipe Bending Co., New Haven, Conn

HEATING SYSTEMS
Warren Webster & Co., Camden.

HOISTS, Skip
Brady Conveyors Corp., Chicago.

HOPPERS AND BINS, Coal and Ash
Brady Conveyors Corp., Chicago.

ICE MAKING & REFRIGERATING MACHINERY
Vogt Machine Co., Inc., Henry, Louisville, Ky.

INSTRUMENTS, Electrical
General Elec. Co., Schenectady.

INSULATING MATERIAL
Carey Co., Philip, Cincinnati.
General Elec. Co., Schenectady.
General Insulating & Mfg. Co., Alexandria, Ind.

JOINTS, Expansion
Badger & Sons, E. B., Boston, Mass.
Foster Wheeler Corp., New York.
Howard Iron Works, Buffalo.
Yarnall Waring Co., Phila.

LADDER STEPS, Steel
Dravo-Doyle Co., Pittsburgh.
Tri-Lok Co., Pittsburgh.

LININGS, Coal Bunker
Wailes Dove-Hermiston Corp., N. Y.

LOADERS AND UNLOADERS
Brady Conveyors Corp., Chicago.

LUBRICANTS
Brooks Oil Co., Cleveland, O.
Cities Service Co., New York, N. Y.
Dearborn Chemical Co., Chicago.
Keystone Lubricating Co., Phila.
Standard Oil Co. (Indiana), Chicago, Ill.
Texas Co., The, New York.
Vacuum Oil Co., New York.

LUBRICATORS
Keystone Lubricating Co., Phila.
Williams Valve Co., D. T., Cincinnati.

METERS, Air and Gas
Bailey Meter Co, Cleveland, O.
Republic Flow Meters Co., Chicago

METERS, Boiler
Bailey Meter Co., Cleveland, O.
Brown Inst. Co., Phila., Pa.
Republic Flow Meters Co., Chicago.

METERS, Coal
Bailey Meter Co., Cleveland, O.
C. J. Mfg. Co., Philadelphia, Pa.
Republic Flow Meters Co., Chicago.

METERS, Feedwater and Steam
Bailey Meter Co., Cleveland, O.
Brown Inst. Co., Phila., Pa.
Cochrane Corp., Philadelphia.
Hoppes Mfg. Co., Springfield, O.
Republic Flow Meters Co., Chicago.
Simplex Valve & Meter Co., Philadelphia.
Worthington Pump & Mach. Corp., New York.

METERS V NOTCH
Yarnall-Waring Co., Phila.

METERS, Water
Bailey Meter Co., Cleveland, O.
Cochrane Corp., Philadelphia.
Hoppes Mfg. Co., Springfield, O.
International Filter Co., Chicago.
Republic Flow Meters Co., Chicago.
Simplex Valve & Meter Co., Philadelphia.

MONEL METAL RINGS, RODS, CASTINGS, FORGINGS, TUBING, SHEETS, WIRE & WIRE CLOTH
International Nickel Co., New York, N. Y.

MOTORS
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Elliott Co., Ridgway, Pa.
Fairbanks, Morse & Co., Chicago.
General Elec. Co., Schenectady.

NOZZLES FOR ALL PURPOSES
Marley Co., Kansas City, Mo.
Yarnall-Waring Co., Phila.

OIL AND GREASE CUPS
Keystone Lubricating Co., Phila.
Williams Valve Co., D. T., Cincinnati.

OIL, Coal and Gas Burning Equipment
Combustion Engrg. Corp., N. Y.
Engineer Co., New York, N. Y.
Hammel Oil Burning Equipment Co., Inc., Providence,
Peabody Engrg. Corp., N. Y.

OIL PURIFIERS
De Laval Separator Co., N. Y.
De Laval Steam Turbine Co., Trenton, N. J.

OIL SEPARATORS
De Laval Separator Co., N. Y.
Wright-Austin Co., Detroit, Mich.

OIL TESTING APPARATUS
Burgess-Parr Co., Chicago, Ill.

OILING SYSTEMS
Burt Mfg. Co., The, Akron, O.
De Laval Separator Co., N. Y.

OILS, Lubricating
Brooks Oil Co., Cleveland, O.
Cities Service Co., New York, N. Y.
Dearborn Chemical Co., Chicago.
Standard Oil Co. (Indiana), Chicago, Ill.
Texas Co., The, New York.
Vacuum Oil Co., New York.

PACKING ASBESTOS, Flax and Metallic
Crane Packing Co., Chicago.

PACKING, Metallic for Condenser Tubes
Crane Packing Co., Chicago.

PACKING, Piston and Rod, Valve Stem
Crane Packing Co., Chicago.

PACKING, Sheet
Jenkins Bros., New York, N. Y.

PAINT, Acid, Alkali and Water Resistant
Wailes Dove-Hermiston Corp., New York, N. Y.

PAINT, Anti-Corrosive, Metal, Protective & Steel Preservative
Dampney Co. of Amer., Boston.
Master Mechanics Co., Cleveland.
Wailes Dove-Hermiston Corp., New York, N. Y.

PAINT, Floor
Wailes Dove-Hermiston Corp., New York, N. Y.

PAINT, Heat Resisting
Dampney Co. of Amer., Boston.
Wailes Dove-Hermiston Corp., New York, N. Y.

PENSTOCKS
Smith Co., S. Morgan, York, Pa.

PIPE BENDING
Badger & Sons, E. B., Boston, Mass.
Midwest Piping & Supply Co., St. Louis, Mo.
National Pipe Bending Co., New Haven, Conn.
Pittsburgh Piping & Equipment Co., Pittsburgh, Pa.

To Find the Manufacturers' Advertisements of Products Listed Here, See Index Page 1 6

PIPE COILS
Badger & Sons, E. B., Boston, Mass.
Midwest Piping & Supply Co., St. Louis, Mo.
National Pipe Bending Co., New Haven, Conn.
Pittsburgh Piping & Equipment Co., Pittsburgh, Pa.
Vogt Machine Co., Inc., Henry, Louisville, Ky.

PIPE COVERINGS
Carey Co., Philip, Cincinnati.
General Insulating & Mfg. Co., Alexandria, Ind.

PIPE CUTTERS
Toledo Pipe Threading Mach. Co., The, Toledo, O.

PIPE THREADING MACHINES
Toledo Pipe Threading Mach. Co., The, Toledo, O.

PIPING
Midwest Piping & Supply Co., St. Louis, Mo.
Pittsburgh Piping & Equipment Co., Pittsburgh.

PIPING CONTRACTING MANUFACTURERS AND FABRICATORS
Midwest Piping & Supply Co., St. Louis, Mo.
Pittsburgh Piping & Equipment Co., Pittsburgh, Pa.

PROTECTIVE COATINGS
Dampney Co. of Amer., Boston.
Master Mechanics Co., Cleveland.
Wailes Dove-Hermiston Corp., New York, N. Y.

PULVERIZED COAL BURNERS
Fuller Lehigh Co., New York.
Peabody Engrg. Corp., N. Y.

PULVERIZED COAL FEEDERS
Fuller Lehigh Co., New York.

PULVERIZED FUEL EQUIPMENT
Combustion Engrg. Corp., N. Y.
Foster Wheeler Corp., N. Y.
Fuller Lehigh Co., New York.
Kennedy-Van Saun Mfg. & Eng. Corp., New York, N. Y.

PULVERIZERS, Coal and Limestone,
Fuller Lehigh Co., New York.
Kennedy-Van Saun Mfg. & Eng. Corp., New York, N. Y.
Northern Blower Co., Cleveland.

PUMPS, Boiler Feed
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
De Laval Steam Turbine Co., Trenton, N. J.
Fairbanks, Morse & Co., Chicago.
Foster Wheeler Corp., New York.
Frederick Iron & Steel Co., Frederick, Md.
Manistee Iron Works Co., Manistee, Mich.
Moore Steam Turbine Corp., Wellsville, N. Y.
Warren Steam Pump Co., Inc., Warren, Mass.
Worthington Pump & Machy. Corp., New York.

PUMPS, Centrifugal
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
De Laval Steam Turbine Co., Trenton, N. J.
Fairbanks, Morse & Co., Chicago.
Foster Wheeler Corp., New York.
Frederick Iron & Steel Co., Frederick, Md.
Manistee Iron Works Co., Manistee, Mich.
Moore Steam Turbine Corp., Wellsville, N. Y.
Nash Engrg. Co., S. Norwalk.
Warren Steam Pump Co., Inc., Warren, Mass.
Worthington Pump & Mach. Corp., New York.

PUMPS, Deep Well
Fairbanks, Morse & Co., Chicago.
Worthington Pump & Mach. Corp., New York.

PUMPS, Elevator and Fire, General Service
De Laval Steam Turbine Co., Trenton, N. J.
Frederick Iron & Steel Co., Frederick, Md.
Manistee Iron Works Co., Manistee, Mich.
Nash Engrg. Co., S. Norwalk.
Warren Steam Pump Co., Inc., Warren, Mass.

PUMPS, Hydraulic Pressure
Manistee Iron Works Co., Manistee, Mich.
Warren Steam Pump Co., Inc., Warren, Mass.

PUMPS, Oil
Frederick Iron & Steel Co., Frederick, Md.
Hammel Oil Burning Equipment Co., Inc., Providence,
Warren Steam Pump Co., Inc., Warren, Mass.

PUMPS, Power and Electric
Fairbanks, Morse & Co., Chicago.
Frederick Iron & Steel Co., Frederick, Md.
Warren Steam Pump Co., Inc., Warren, Mass.
Worthington Pump & Mach. Corp., New York.

PUMPS, Pulverized Coal
Fuller Lehigh Co., New York.

PUMPS, Rotary
Manistee Iron Works Co., Manistee, Mich.

PUMPS, Turbine
Moore Steam Turbine Corp., Wellsville, N. Y.

PUMPS, Vacuum
Foster Wheeler Corp., New York.
Manistee Iron Works Co., Manistee, Mich.
Nash Engrg. Co., S. Norwalk.
Warren Steam Pump Co., Inc., Warren, Mass.

PUMPS, Waterworks
Fairbanks, Morse & Co., Chicago.
Frederick Iron & Steel Co., Frederick, Md.
Manistee Iron Works Co., Manistee, Mich.
Moore Steam Turbine Corp., Wellsville, N. Y.
Warren Steam Pump Co., Inc., Warren, Mass.

PURIFIERS, Boiler Feed
Cochrane Corp., Philadelphia.
Hoppes Mfg. Co., Springfield, O.
International Filter Co., Chicago.
Permutit Co., New York.
Scaife & Sons Co., Wm. B., Oakmont, Pa.

PURIFIERS, Steam
Centrifix Corp., Cleveland.
International Filter Co., Chicago.
Marley Co., Kansas City, Mo.

PYROMETERS
Bristol Co., Waterbury.
Brown Inst. Co., Phila., Pa.
Republic Flow Meters Co., Chicago, Ill.

RECORDERS, Draft and Gravity
Hays Corp., Michigan City, Ind.

RECORDERS, Liquid Level
Bristol Co., Waterbury.

RECORDING INSTRUMENTS
Bristol Co., Waterbury.
Hays Corp., Michigan City, Ind.
Simplex Valve & Meter Co., Philadelphia.

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TEXACO LUBRICANTS

REGULATORS, Damper
Atlas Valve Co., Newark, N. J.
Brown Inst. Co., Phila., Pa.
Engineer Co., New York, N. Y.
Ruggles-Klingemann Mfg. Co., Salem, Mass.

REGULATORS, Fan Engine
Atlas Valve Co., Newark, N. J.

REGULATORS, Feed Water
Atlas Valve Co., Newark, N. J.
Bailey Meter Co., Cleveland.
Chaplin-Fulton Mfg. Co., Pittsburgh.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Sarco Co., Inc., New York.
Squires Co., C. E., Cleveland.
Wright-Austin Co., Detroit, Mich.

REGULATORS, Pressure
Fisher Governor Co., Inc., Marshalltown, Ia.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Sarco Co., Inc., New York, N. Y.
Squires Co., C. E., Cleveland.

REGULATORS, Temperature
Atlas Valve Co., Newark, N. J.
Bristol Co., Waterbury.
Brown Inst. Co., Phila., Pa.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Sarco Co., Inc., New York, N. Y.

RUST PREVENTIVES
Dearborn Chem. Co., Chicago.
Wailes Dove-Hermiston Corp., New York, N. Y.

SCALE REMOVERS (Mechanical)
General Specialty Co., Buffalo.
Lagonda Mfg. Co., Springfield, Ohio.
Liberty Mfg., Pittsburgh.
Pierce Co., Wm. B., Buffalo.
Roto Co., The, Newark, N. J.

SCALES, Coal
Richardson Scale Co., Clifton, N. J.

SEPARATORS AND EXTRACTORS, Steam and Oil
Centrifix Corp., Cleveland.
Cochrane Corp., Philadelphia.
Direct Separator Co., Syracuse.
Hoppes Mfg. Co., Springfield, O.
Marley Co., Kansas City, Mo.
National Pipe Bending Co., The, New Haven, Conn.
Williams Valve Co., D. T., Cincinnati.
Wright-Austin Co., Detroit, Mich.

SILENCERS
Burgess Battery Co., Chicago, Ill.

SLUICING SYSTEMS, Ash
Brady Conveyors Corp., Chicago.

SODIUM ALUMINATE
National Aluminate Corp., Chicago, Ill.

SOOT BLOWERS
Bayer Co., The, St. Louis, Mo.
Diamond Power Spec. Corp., Detroit, Mich.

SPRAY AIR WASHERS
Badger & Sons, E. B., Boston, Mass.

SPRAY COOLING SYSTEMS, Towers and Nozzles
Badger & Sons, E. B., Boston, Mass.
Binks Mfg. Co., Chicago.
Marley Co., The, Kansas City, Mo.
Schubert-Christy Corp., Affton, Mo.
Yarnall-Waring Co., Phila.

SPRAY PONDS
Binks Mfg. Co., Chicago.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford, Mass.

STAIR TREAD, Anti-Slip
Dravo-Doyle Co., Pittsburgh.
Tri-Lok Co., Pittsburgh.

STACKS, Metal
Vogt Machine Co., Inc., Henry, Louisville, Ky.

STEAM TRAPS
Armstrong Machine Wks., Three Rivers, Mich.
Bundy Steam Trap Co., Nashua, Cochrane Corp., Philadelphia.
Fisher Governor Co., Inc., Marshalltown, Ia.
Kaye & MacDonald, Inc., West Orange, N. J.
Reliance Gauge Column Co., Cleveland.
Sarco Company, Inc., New York.
Squires Co., C. E., Cleveland.
Williams Valve Co., D. T., Cincinnati.
Wright-Austin Co., Detroit, Mich.

STOCKS AND DIES
Toledo Pipe Threading Mach. Co., The, Toledo, O.

STOKERS, Chain Grate
Combustion Engrg. Corp., N. Y.

STOKERS, Hand Operated
Flynn & Emrich Co., Baltimore.
Kelly Foundry & Mach. Co., The, Goshen, Ind.
Neemes Foundry, Inc., Troy, N. Y.

STOKERS, Mechanical
American Eng'r'g Co., Phila.
Combustion Engrg. Corp., N. Y.
Detroit Stoker Co., Detroit, Mich.
Flynn & Emrich Co., Baltimore.
Neemes Foundry, Inc., Troy, N. Y.

STOKERS, Overfeed
Detroit Stoker Co., Detroit, Mich.
Flynn & Emrich Co., Baltimore.

STOKERS, Underfeed
American Eng'r'g Co., Phila.
Combustion Engrg. Corp., N. Y.
Detroit Stoker Co., Detroit, Mich.

STRAINERS
Elliott Co., Jeannette, Pa.
Sarco Co., Inc., New York.
Wright-Austin Co., Detroit.

STRAINERS, Oil
Hammel Oil Burning Equipment Co., Inc., Providence,
Sarco Co., Inc., New York.

SUPERHEATERS, Steam
Foster Wheeler Corp., N. Y.
Marley Co., The Kansas City.

TUBING, Condenser
Foster-Wheeler Corp., New York

TURBINES, Hydraulic
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
De Laval Steam Turbine Co., Trenton, N. J.
Smith Co., S. Morgan, York, Pa.

TURBINES, Steam
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Carling Turbine Blower Co., Worcester, Mass.
De Laval Steam Turbine Co., Trenton, N. J.
Elliott Co., Jeannette, Pa.
General Elec. Co., Schenectady.
Moore Steam Turbine Co., Wellsville, N. Y.
Terry Steam Turbine Co., Hartford, Conn.

TURBO GENERATORS
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Carling Turbine Blower Co., Worcester, Mass.
Elliott Co., Jeannette, Pa.
General Elec. Co., Schenectady.
Terry Steam Turbine Co., Hartford, Conn.

UNIONS
Atlas Valve Co., Newark, N. J.
Dart Mfg. Co., E. M., Providence, R. I

VALVE DISCS
Jenkins Bros, New York, N. Y.
Metallic Gasket Co., New Brunswick, N. J.

VALVES
Atlas Valve Co., Newark, N. J.
Kennedy Valve Mfg. Co., The, Elmira, N. Y.
Vogt Machine Co., Inc., Henry, Louisville, Ky.

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TACHOMETERS
Bristol Co., Waterbury.
Brown Inst. Co., Phila., Pa.

TANKS
Scaife & Sons Co., Wm. Oakmont, Pa.
Vogt Machine Co., Inc., Henry, Louisville, Ky.

THERMOMETERS, Recording and Indicating
Bristol Co., Waterbury.
Brown Inst. Co., Phila., Pa.

TRAPS, Boiler Return
Bundy Steam Trap Co., Nashua.
Morehead Mfg. Co., Detroit, Mich.

TRAPS, Compressed Air
Armstrong Machine Wks., Three Rivers, Mich.
Bundy Steam Trap Co., Nashua.
Kaye & MacDonald, Inc., West Orange, N. J.

TRAPS, Radiator
Warren Webster & Co., Camden.

TRAPS, Return
Warren Webster & Co., Camden.

TRAPS, Steam & Radiator
Armstrong Machine Wks., Three Rivers, Mich.
Bundy Steam Trap Co., Nashua.
Kaye & MacDonald, Inc., West Orange, N. J.
Morehead Mfg. Co., Detroit, Mich.
Sarco Co., Inc., New York.
Warren Webster & Co., Camden.

TRAPS, Vacuum
Armstrong Machine Wks., Three Rivers, Mich.
Bundy Steam Trap Co., Nashua.
Kaye & MacDonald, Inc., West Orange, N. J.
Warren Webster & Co., Camden.

TUBE CUTTERS
Lagonda Mfg. Co., Springfield, O.

VALVES, Altitude
Simplex Valve & Meter Co., Philadelphia.

VALVES, Automatic Cut-Off
Fisher Governor Co., Inc., Marshalltown, Ia.

VALVES, Automatic Stop and Check
Ruggles-Klingemann Mfg. Co., Salem, Mass.

VALVES, Blow-Off
Homestead Valve Mfg. Co., Coraopolis, Pa.
Jenkins Bros., New York, N. Y.
Yarnall-Waring Co., Phila.

VALVES, By-Pass
Jenkins Bros., New York, N. Y.

VALVES, Check
Bundy Steam Trap Co., Nashua,
Homestead Valve Mfg. Co., Coraopolis, Pa.
Jenkins Bros., New York, N. Y.
Kennedy Valve Mfg. Co., The, Elmira, N. Y.
Williams Valve Co., D. T., Cincinnati.

VALVES, Float
Atlas Valve Co., Newark, N. J.
Fisher Governor Co., Inc., Marshalltown, Ia.

VALVES, Gate
Jenkins Bros., New York, N. Y.
Kennedy Valve Mfg. Co., The, Elmira, N. Y.
Vogt Machine Co., Inc., Henry, Louisville, Ky.
Williams Valve Co., D. T., Cincinnati.

VALVES, Globe
Homestead Valve Mfg. Co., Coraopolis, Pa.
Jenkins Bros., New York, N. Y.
Kennedy Valve Mfg. Co., The, Elmira, N. Y.
Vogt Machine Co., Inc., Henry, Louisville, Ky.
Williams Valve Co, D. T., Cincinnati.

VALVES, Hydraulic
Homestead Valve Mfg. Co., Coraopolis, Pa.
Kennedy Valve Mfg. Co., The, Elmira, N. Y.
Vogt Machine Co., Inc., Henry, Louisville, Ky.

VALVES, Non-Return
Elliott Co., Jeanette, Pa.
Ruggles-Klingemann Mfg. Co., Salem, Mass.

VALVES, Pump
Fisher Governor Co., Inc., Marshalltown, Ia.
Jenkins Bros., New York, N. Y.

VALVES, Radiator
Jenkins Bros., New York, N. Y.
Kennedy Valve Mfg. Co., The, Elmira, N. Y.
Sarco Co., Inc., New York.
Williams Valve Co., D. T., Cincinnati.

VALVES, Reducing and Regulating
Atlas Valve Co, Newark, N. J.
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Fisher Governor Co., Inc., Marshalltown, Ia.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Squires Co., C. E., Cleveland, O.

VALVES, Regrinding.
Homestead Valve Mfg. Co., Coraopolis, Pa.
Kennedy Valve Mfg. Co., The, Elmira, N. Y.
Williams Valve Co., D. T., Cincinnati

VALVES, Relief
Cochrane Corp., Philadelphia.
Fisher Governor Co., Inc., Marshalltown, Ia.

VALVES, Steel
Kennedy Valve Mfg. Co., The, Elmira, N. Y.

VALVES, Stop
Homestead Valve Mfg. Co., Coraopolis, Pa.

VENTILATING APPARATUS
Badger & Sons, E. B., Boston, Mass.
Burt Mfg. Co., The, Akron, O.

WALKWAYS, Open Steel
Dravo-Doyle Co., Pittsburgh.
Tri-Lok Co., Pittsburgh.

WASTE HEAT RECOVERY SYSTEMS
Edge Moor Iron Co., Edge Moor.

WATER BACKS, High & Low Pressure
Foster Wheeler Corp., New York.

WATER COLUMNS AND ALARMS
Reliance Gauge Column Co., The, Cleveland, O.
Wright-Austin Co.
Yarnall-Waring Co., Phila.

WATER COOLING EQUIPMENT
Marley Co., The, Kansas City.
Schubert-Christy Corp., Affton, Mo.

WATER GATES
Smith Co., S. Morgan, York, Pa.

WATER PURIFYING AND SOFTENING SYSTEMS
Cochrane Corp., Philadelphia.
Dearborn Chemical Co., Chicago.
Elgin Softener Corp., Elgin, Ill.
Griscom-Russell Co.
International Filter Co., Chicago.
National Aluminate Corp., Chicago, Ill.
Permutit Co., New York.
Scaife & Sons Co., Wm. B., Oakmont, Pa.

WATER TESTING EQUIPMENT
Burgess-Parr Co., Chicago, Ill.
International Filter Co., Chicago.
National Aluminite Corp., Chicago, Ill.

WATER WALLS
Edge Moor Iron Co., Edge Moor.
Fuller Lehigh Co., New York.
Springfield Boiler Co., Springfield, Ill.

WEIGH LARRIES
Richardson Scale Co., Clifton, N. J.

WEIGHING MACHINERY
Richardson Scale Co., Clifton, N. J.

WELDED HEADERS
Midwest Piping & Supply Co., St. Louis, Mo.

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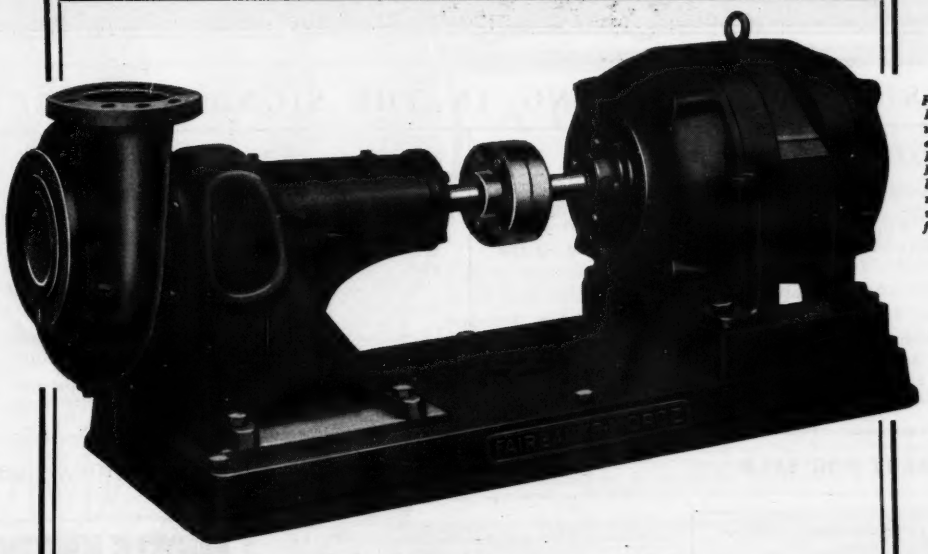

F-M Fig. 5530 Ball Bearing Centrifugal Pump mounted on base with F-M Ball Bearing Motor. Pump may be purchased separately or as a unit with motor. Sizes from 1 to 8 inches.

to pump users

A remarkable line of side-suction pumps for belt drive or direct connection

The Fairbanks-Morse Fig. 5520 and Fig. 5530 Ball Bearing Centrifugal Pumps are the most remarkable side-suction pumps ever developed. Here is a line of low-priced, highly efficient pumps built of the finest materials and incorporating many unique features of design. These pumps offer more value per dollar than any heretofore presented to the trade.

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32 branches at your service throughout the United States

Check These Features!

Efficiencies as high as many double-suction pumps

Unusual mechanical refinements including ball bearings

Maximum dependability with lowest maintenance costs

Accessibility with simplicity of assembly

Moderate in price because of volume production

Write for Bulletin No. 5020 covering this remarkable line of closed impeller ball bearing pumps

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Advertisements published in the Signboard Section which come under the classifications of "Positions Wanted"—"Engineers Wanted"—"Salesmen & Agencies"—"Patent Attorneys"—etc., are charged for by the line.

The rate per line for one insertion is—50c

The minimum advertisement accepted is four lines. Classified advertisements are all printed in the same style and sizes of type. No display type is used. Box numbers can be used. Replies are forwarded promptly.

DISPLAY RATES

The unit of space used for advertisements under the headings of "Equipment Wanted"—"Equipment for Sale"—"Technical Books"—"Professional Cards"—etc., is the column-inch which is one column (2¼ in.) wide and one inch deep. The basis rate is $5.50 for one column-inch in one issue. This basis rate decreases as larger space or more than one issue is used.

Quotations will be sent promptly on request for any desired size of space or number of insertions.

Display headings, bold-face or italic type and signature cuts are permissible in Display Advertisements.

EQUIPMENT FOR SALE

A.C. TURBINES

1250 KVA G.E. Condensing, "1923"
780 KVA Wghse., Condensing, "1924"
625 KVA Wghse. (bleeder), "1920"
625 KVA Wghse. (5-40 lb. b.p.), "1921"
375 KVA G.E. (5-10 lb. b.p.), "1921"

A.C. UNITS

780 KVA Burke—24x30 Erie Ball 4 v.
750 KVA Wghse.—30x34 Ames Uniflow
400 KVA G.E.—20x32 Nordberg Uniflow
312 KVA G.E.—21x21 Skinner Uniflow
150 KVA C.W.—18x30 Hardy Tynes Cor.
150 KVA G.E.—14x16 Skinner Uniflow

BOILERS (ASME)

750 HP Sterling, 225 lb., "1926"
737 HP (2) Edgemoor, 200 lb., "1927"
623 HP Erie City, 250 lb., "1927"
514 HP (3) B&W, 225 lb., "1925"
404 HP (2) Springfield, 225 lb., "1923"
305 HP Heine, 200 lb., "1929"
230 HP Edgemoor, 210 lb., "1923"

Power Plant Equipment Co., Inc.
39-41 Cortlandt St., New York City, N. Y.

POSITIONS WANTED

FULLY EXPERIENCED Power Plant Engineer. Has held New Jersey license for 16 years. Familiar with boilers, engines, turbines, generator sets and electrical equipment, as well as auxiliary equipment such as compressors, pumps, etc. Will go anywhere an opportunity presents itself. Please write to me, Box 1130, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

MECHANICAL OR ELECTRICAL ENGINEER. University graduate, 38, married; broad experience with central station and industrial plants. Experience includes plant surveys for power and heat, recommendations for improvements, estimating cost and savings; complete design of power plants, supervision of construction, operation and maintenance. Box 1127, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

INSTRUMENT MAN available. Experienced in combustion work. Engineering degree from Michigan State College. Can furnish references from large utility company. Fully capable of taking responsibility of instrument maintenance or combustion efficiency. Please write to Box 1124, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

MECHANICAL ENGINEER: B. S. and M. E. degrees. Refrigerating, hydro, and testing experience. Formerly in responsible charge of the piping design of large steam central stations. Desires position with utility, industrial or sales organization. Please write to Box 1123, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

POSITIONS WANTED

HERE IS A MAN who during his fifteen years of power plant and engineering experience has kept an open and inquiring mind and has learned thoroughly both the theory and operation of all branches of power plant practice. He is thoroughly competent to handle refrigeration equipment, switchboard and electrical apparatus, as well as the regular engine and boiler room machinery. He is not tied down in any way and is eager to take up work in any part of North or South America. Any company seeking an engineer would do well to investigate this man. Write to Box 1133, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

EXPERIENCED ENGINEER available. Plant engineer or assistant. 27 years old, single. 2 years experience in electrical maintenance, plumbing and heating. Also 2 years in manufacturing planning. Executive ability. New England or New York location preferred. Please write to Box 1128, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

YOUNG MAN with excellent training in the special problems of the small plant wants a position with a live industrial power plant. 26 yrs. of age, married. Location and salary secondary to opportunity. Five yrs. experience. Graduated from Mechanical course, International Correspondence Schools. Ready to tackle your problems with enthusiasm and punch. Please write to Box 1121, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

SALESMEN AND AGENCIES

BALTIMORE & WASHINGTON representative available. Sales engineer with twelve years of contact invites correspondence with reliable manufacturers who desire competent representation in these territories. Please reply to Box 1132, c/o Power Plant Engineering, 53 West Jackson Blvd., Chicago, Ill.

WANTED: SALES MANAGER. Old established concern building power plant equipment has a position open for a good, live, Sales Manager. Advise in application, age, residence and salary expected. This is a fine position for the right party. Box 1131, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

WHY PAY OVERHEAD and expenses for New York office when this reputable concern with complete organization, with twenty-three years experience in this territory will represent you efficiently, if your product is high grade? Write to us through Box 1129, c/o Power Plant Engineering, 53 West Jackson Blvd., Chicago, Ill.

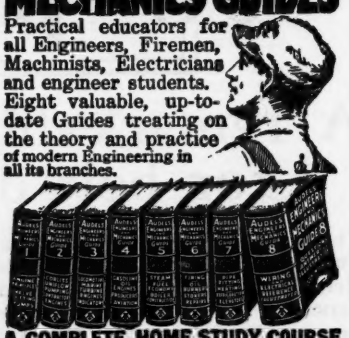
PATENT ATTORNEYS

PATENTS—Booklet free. Highest references. Best results. Promptness assured. Send drawing or model. WATSON E. COLEMAN, Registered Patent Lawyer, 724 9th Street, Washington, D. C.

TECHNICAL BOOKS

AUDELS ENGINEERS & MECHANICS GUIDES

Practical educators for all Engineers, Firemen, Machinists, Electricians and engineer students. Eight valuable, up-to-date Guides treating on the theory and practice of modern Engineering in all its branches.



A COMPLETE HOME STUDY COURSE AND REFERENCE LIBRARY

$1 8 pocket numbers with Ready Reference Index. 8754 pages. 4750 illustrations. Easy to read. Highly endorsed. A good help in securing Engineer's License. Price $12; terms, $1 per month. Free Trial.

INFORMATION: — *In A Handy Form.* Answers to Your Questions and Problems. Here is a partial list of the subjects covered:— **Engine Principles, Valve Setting, Pumps, Corliss Engines, Uniflow Engines, Pumping Engines, Contractors Engines, Locomotives, Marine Engines, Turbine Engines, Gas Engines, Oil Engines, Indicators, Producers, Aviation, Steam, Fuel Economy, Boiler Construction, Firing, Oil Burners, Stokers, Boiler Repairs, Pipe Fitting, Heating, Refrigeration, Elevators, Dynamos, Motors, Lighting, Wiring, Electrical Diagrams, Radio, Electrical Reference and Calculations.**

SHIPPED FREE

Not a cent to pay until you see the books. No obligation to buy unless you are satisfied. Fill in coupon *in pencil*. Send now—today—get this standard library for Engineers and Mechanics.

FREE EXAMINATION COUPON

Theo. Audel & Co., 65 W. 23 St., N.Y. City
Send me AUDELS ENGINEERS AND MECHANICS GUIDES. 8 numbers, $12, for *free examination*. If satisfactory, I will send you $1 in 7 days, then $1 monthly until $12 is paid.

Name.....
Address.....
Occupation.....
Employed by..... P P.E

PITTSBURGH PIPING

PP&E Co

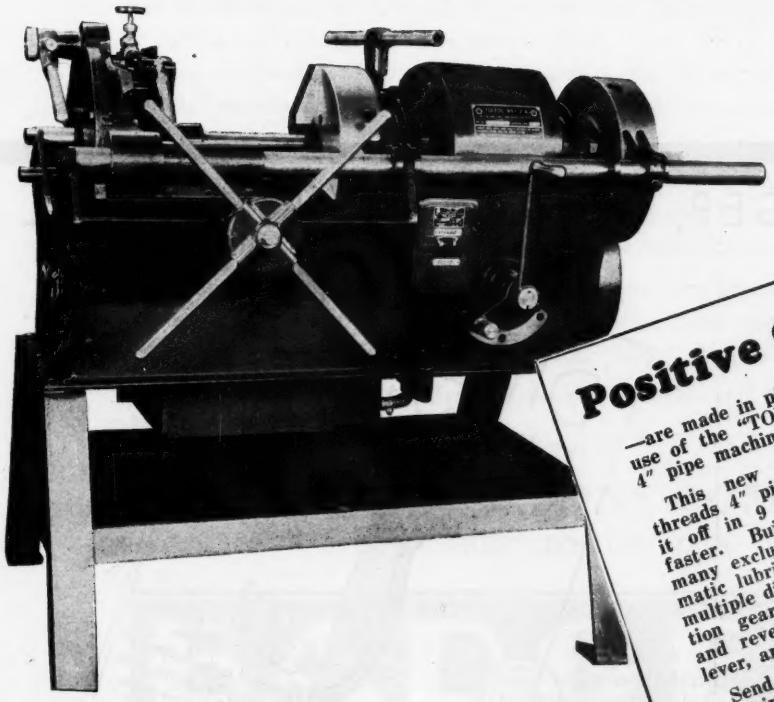
A Good Idea for Power Plants

The successful operation of expensive power plant equipment depends to a large extent upon the satisfactory performance of the piping system. Because PITTSBURGH PIPING & EQUIPMENT COMPANY maintains accuracy, strength and reliability are important factors in the efficient operation of Power Plants, it's a good idea to specify . . . PITTSBURGH PIPING.

Pittsburgh Piping & Equipment Company
43rd Street & A. V. R. R. Pittsburgh, Pa.
Branch offices in principal cities

The photograph shows boiler piping in The Bremo Station of the Virginia Public Service Company, Bremo Bluff, Va. Designed and constructed by the Electric Management & Engineering Corporation of New York.

"WHEN YOU THINK OF PIPING, THINK OF PITTSBURGH PIPING."



Positive Savings—

—are made in piping work through the use of the "TOLEDO" No. 1-2-4 1" to 4" pipe machine.

This new high speed "TOLEDO" threads 4" pipe in 42 seconds and cuts it off in 9 seconds, other sizes even faster. Built sturdy and strong with many exclusive features, such as automatic lubrication, centrifugal oil pump, multiple disc friction clutch, safety friction gear, six spindle speeds forward and reverse with one clutch and gear lever, and many others.

Send for complete information. The amazing facts found therein will convince you of its superiority.

THE TOLEDO PIPE THREADING MACHINE CO.
TOLEDO, OHIO New York Office, 71 Lafayette St.

"TOLEDO" No. 1-2-4
1" to 4" PIPE MACHINE

"TOLEDO"

ANNOUNCING!

another outstanding in the design of

AN IMPROVED CORRUGATION

A STRONGER, MORE DURABLE METAL

Familiar Features of the Badger Self-Equalizing Expansion Joints

no packing used, hence no maintenance

compactness and ease of installation

monel metal sleeve for superheated steam

choice of welding or flanged ends

Send for this illustrated bulletin. It tells in detail all about the new principle of Directed Flexing now embodied in all Badger Self-Equalizing Expansion Joints.

improvement by BADGER *expansion joints . . .*

DIRECTED FLEXING

of the compensating member

THE secret of being able to flex a piece of sheet metal interminably is in completely distributing the stresses. Keep these stresses from concentrating in one or more spots and the life of the metal is greatly prolonged.

This is the action and result brought about by the *new* design of corrugation and equalizing ring for the Badger Expansion Joint. Each corrugation is entirely curved and during flexing remains curved. There are no places where stresses can localize. The movement is undulating throughout. "Directed Flexing" expresses the whole action precisely. Longer life is the result.

And with the development of this new corrugation came the application of a new metal, Everdur, which has all the advantages of copper and in addition is stronger, more durable and more resilient. These properties make it possible to meet higher pressures and to take care of more expansion and contraction.

This important improvement—the latest of several brought out by Badger engineers—means still lower maintenance costs for those equipping steam lines with expansion joints. As with all Badger Joints, there is no servicing.

Write to the nearest Badger office for descriptive folder and for prices and deliveries.

E. B. BADGER & SONS COMPANY

71 PITTS STREET, BOSTON, MASS.

BADGER EXPANSION JOINTS

BRANCHES

Atlanta, Georgia, 140 Edgewood Ave.
Charlotte, N. C., 1408 Independence Building
Chicago, Ill., 2831 South Parkway
Cincinnati, Ohio, Union Trust Bldg.
Cleveland, Ohio, Guardian Building
Detroit, Mich., 402 Ford Building
Houston, Tex., 1308 Sec. Nat. Bk. Bldg.
Indianapolis, Ind., 823 Occidental Bldg.
Kansas City, Mo., 1336 Oak Street
Los Angeles, Cal., 517 Hollingsworth Building
Minneapolis, Minn., 732 Build. Exch.
Montreal, Que., Can., Cement Bldg.
New Orleans, La., 419 Maritime Bldg.
New York City, 271 Madison Ave.
Philadelphia, Pa., 1500 Walnut St. Room 901
Pittsburgh, Pa., Union Trust Bldg.
Salt Lake City, Utah, Kearns Bldg.
San Francisco, Cal., Sharon Bldg.
Seattle, Wash., Smith Tower
St. Louis, Mo., 3605 Laclede Avenue

Padlocked Minds

have no use for a Business Paper...

IT'S not so much *what* you read that counts, as what you read it *for*.

Reading to pass the time away is *one* thing—reading to get *ideas* for improving your business is another.

Men completely satisfied with what they have—insensible to progress—oblivious to change—these read (*when* they read) for entertainment only.

But men whose minds are open to better methods, men whose minds are eager for news of new plans and new practices—these are the men who read the pages of their business papers.

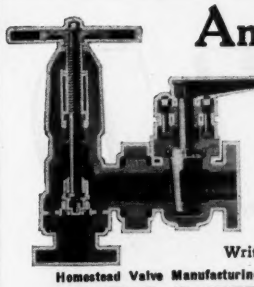
In any industry . . . trade . . . profession, these are the men who count. And just as they are attracted to a publication by the practical, helpful character of its editorial content, so, in the same open-minded mood, they read its advertising pages.

THIS SYMBOL *identifies an ABP paper . . . It stands for honest, known, paid circulation; straightforward business methods, and editorial standards that insure reader interest . . . These are the factors that make a valuable advertising medium.*

THIS PUBLICATION IS A MEMBER OF

THE ASSOCIATED BUSINESS PAPERS, INC.

TWO-NINETY-FIVE MADISON AVENUE, - NEW YORK CITY



An Ideal Hook-up for Blow-off Service

Reversible, regrindable, and renewable seat and disc in the Hovalco assures long continuous service. This combination will outlast the life of the boiler.

Write us for prices or other information.

Homestead Valve Manufacturing Co., P. O. Box 251, Coraopolis, Pa.

HOMESTEAD VALVES

Williams

The complete line of Williams valves answers the demand for uninterrupted service in the modern power plant. Write for descriptive literature or order a sample from your dealer.

THE D. T. WILLIAMS VALVE COMPANY
CINCINNATI, OHIO

Valves

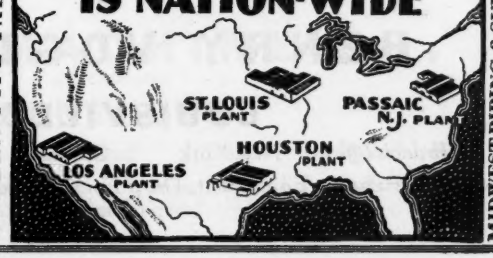
Fig. 326

FIG. 326 Jenkins "Certified" Standard Iron Body Gate Valve for 125 lbs. steam or 200 lbs. oil, water, gas working pressure. JENKINS BROS., 80 White St., New York, N. Y., 524 Atlantic Ave., Boston, Mass.; 133 No. Seventh St., Philadelphia, Pa.; 646 Washington Blvd., Chicago, Ill.; 1121 No. San Jacinto, Houston, Tex. JENKINS BROS., Ltd., Montreal, Can.; London, England.

Jenkins
BRONZE IRON STEEL
VALVES
Since 1864

MODERN PIPE FABRICATION

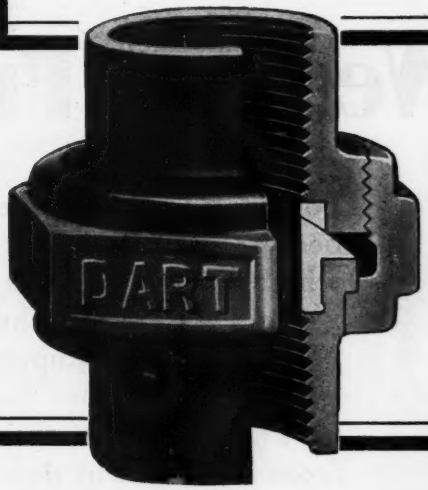
MIDWEST PIPING SERVICE IS NATION-WIDE



MIDWEST PIPING & SUPPLY CO., Inc.
Main Office: St. Louis

double safety *double* service with

DARTS



TODAY'S pipe lines—with higher temperatures and pressures—emphasize anew the important service advantages of Dart Unions. . . . Corrosion-proof bronze-to-bronze seats, heavy malleable construction that endures repeated pipe line strains without leakage, and perfect pipe threads, all tell why Dart Unions are able to give *double* safety and *double* service. . . . Try a sample Dart Union *free* in your plant. Write today for booklet describing complete Dart Line.

E. M. DART MFG. CO.
Providence, R. I.

Sales Agents: The Fairbanks Company, New York, and at all branches

Canadian Factory: Dart Union Company, Ltd., Toronto (2), Canada

HOMOWELD

The Modern Vogt Method of Welding Pressure Vessels

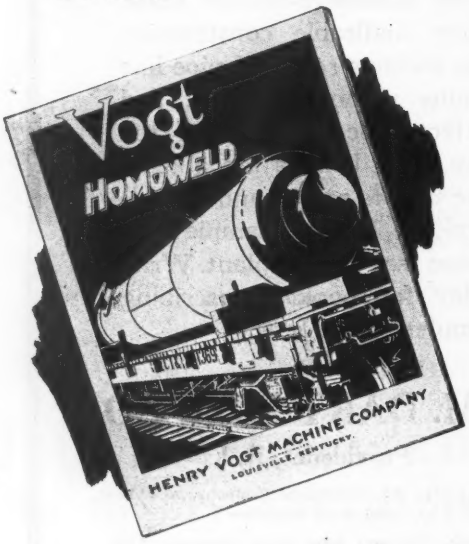
For twenty years the Henry Vogt Machine Company has been fabricating their own products by fusion welding, out of which has come a wealth of experience in producing quality welds. As a result the Vogt welding plant of today, with its personnel and equipment, offers *HOMOWELD*, for the fusion welding of pressure vessels.

The *HOMOWELD* is a metallurgically complete union, free from all harmful defects such as nitride needles, porosity, cracks, slag inclusions, incomplete fusion, segregations, or other flaws.

Special equipment and a skilled welding technique with constant supervision during fabrication assures maximum strength and serviceability of any *HOMOWELDED* boiler drum or pressure vessel constructed for the refinery, chemical, or power field.

We fabricate vessels for every pressure and temperature in any size or shape within transportation limits. Such products are fully insurable and comply with all requirements of the A. S. M. E. code for fusion welding.

The *HOMOWELD* Bulletin W-1 is now being distributed. If you have not received your copy, ask for it.

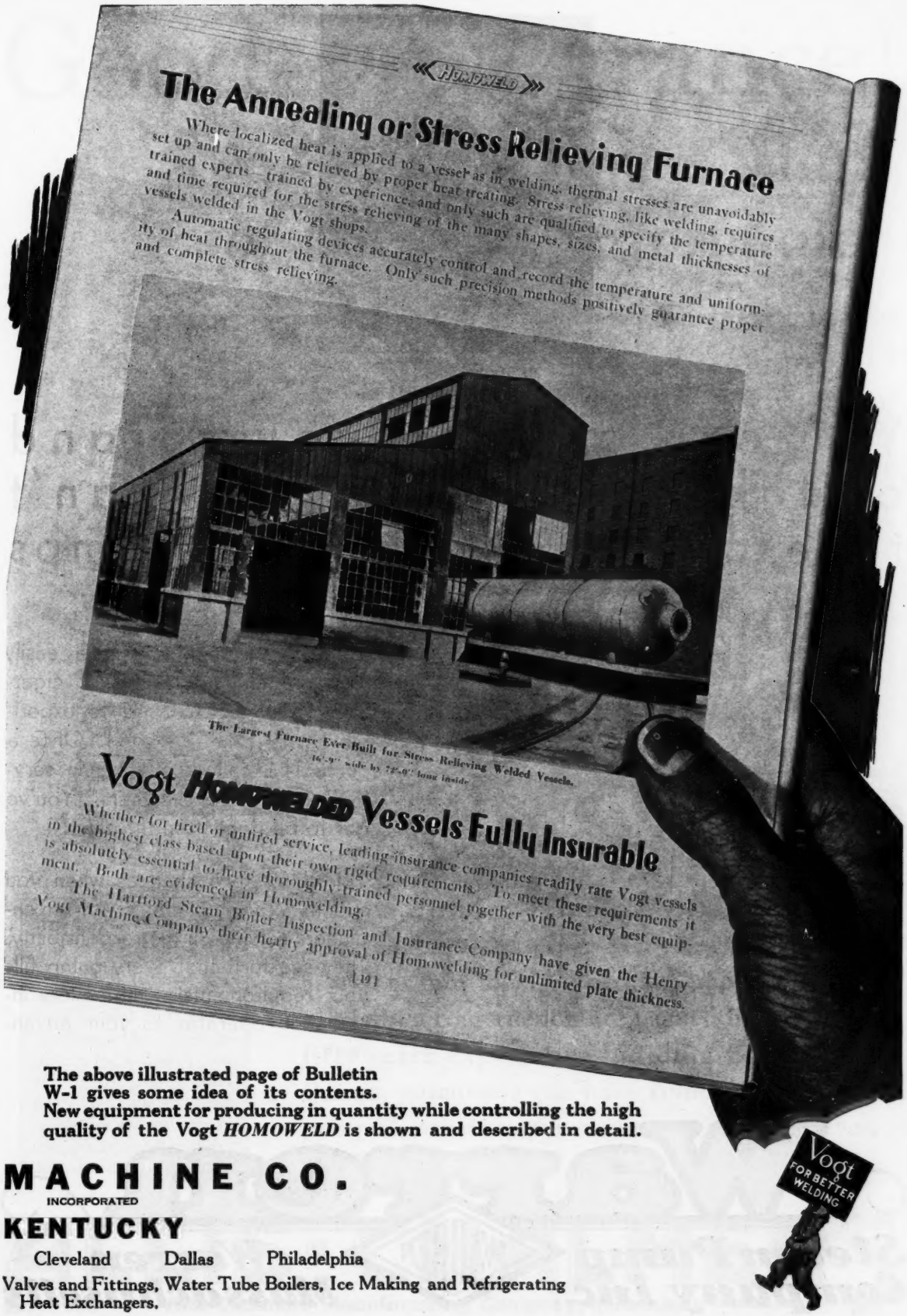


HENRY VOGT

LOUISVILLE,

Branch Offices; New York Chicago

Manufacturers of: Oil Refinery Equipment, Drop Forged Steel Machinery.


HOMOWELD
The Annealing or Stress Relieving Furnace
Where localized heat is applied to a vessel as in welding, thermal stresses are unavoidably set up and can only be relieved by proper heat treating. Stress relieving, like welding, requires trained experts—trained by experience, and only such are qualified to specify the temperature and time required for the stress relieving of the many shapes, sizes, and metal thicknesses of vessels welded in the Vogt shops.
Automatic regulating devices accurately control and record the temperature and uniformity of heat throughout the furnace. Only such precision methods positively guarantee proper and complete stress relieving.
The Largest Furnace Ever Built for Stress Relieving Welded Vessels.
16'-9" wide by 72'-0" long inside
Vogt HOMOWELDED Vessels Fully Insurable
Whether for fired or unfired service, leading insurance companies readily rate Vogt vessels in the highest class based upon their own rigid requirements. To meet these requirements it is absolutely essential to have thoroughly trained personnel together with the very best equipment. Both are evidenced in Homowelding.
The Hartford Steam Boiler Inspection and Insurance Company have given the Henry Vogt Machine Company their hearty approval of Homowelding for unlimited plate thickness.
191

The above illustrated page of Bulletin W-1 gives some idea of its contents. New equipment for producing in quantity while controlling the high quality of the Vogt *HOMOWELD* is shown and described in detail.

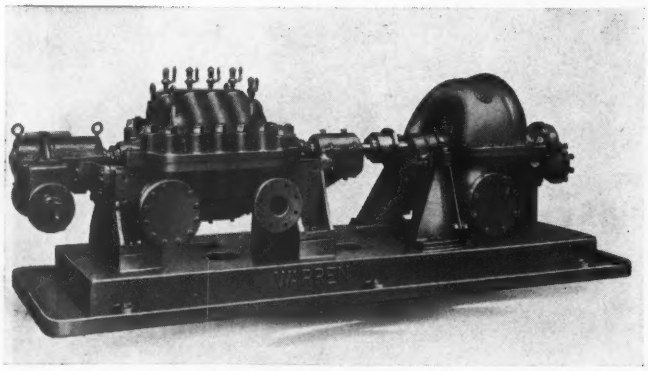
MACHINE CO.
INCORPORATED

KENTUCKY

Cleveland Dallas Philadelphia

Valves and Fittings, Water Tube Boilers, Ice Making and Refrigerating Heat Exchangers.

You can change your brand of tobacco . . . but you can't take chances with your pumps



A Warren 4" five stage boiler feed pump for working against 500 pounds water pressure.

IF you could change pumps as easily as you change brands of cigarettes, you could afford to experiment . . . but you can't. Once a pump is installed, it stays in service for a good many years. You've got to be right from the start.

You don't take chances when you specify Warren pumps. Warren engineers assume all the responsibility. They see to it that every pump fills your requirements — that every installation operates to your advantage.

Warren

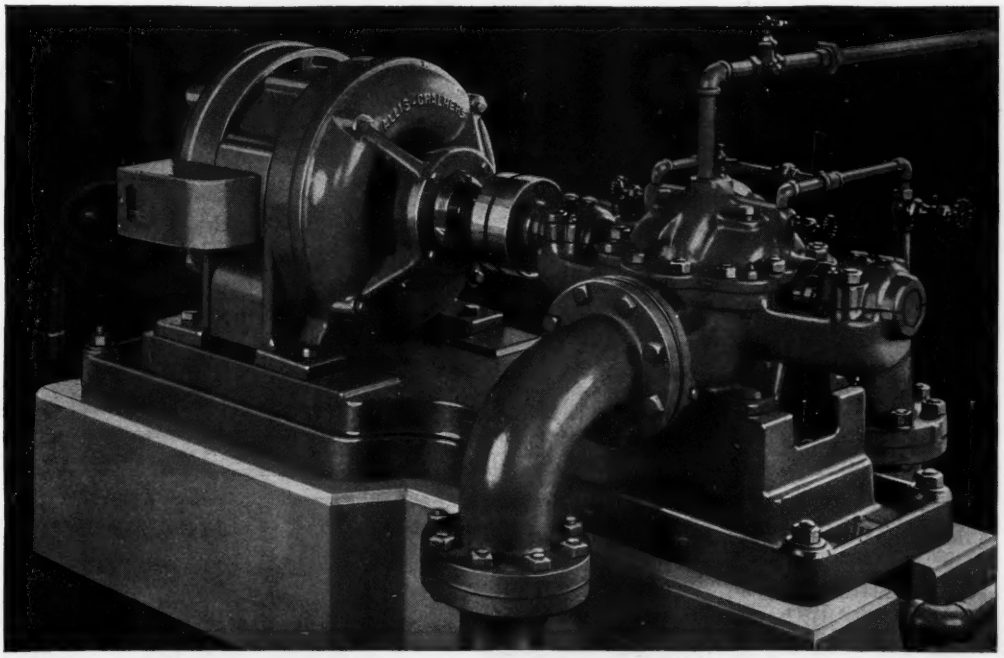
Steam Pump Company Inc. WARREN **Warren Massachusetts**

AGENCIES IN ALL PRINCIPAL CITIES

4940

Good Appearance!

an Allis-Chalmers Mark of Quality Performance



Centrifugal Pumps

The Allis-Chalmers line consists of low, moderate, and high head single stage pumps of 1″ to 72″ discharge, multi-stage pumps for working pressure up to 1500 pounds, high efficiency paper stock pumps, and pumps for special applications.

ALLIS-CHALMERS Centrifugal Pumping Units have a fine substantial appearance and it is a reasonable assumption that they will perform as well as they look. When fine appearance and substantial construction are backed up by nearly fifty years experience building Centrifugal Pumps, purchasers can have confidence in these pumps for their requirements. A trial, however, will be the best proof.

ALLIS-CHALMERS

Allis-Chalmers Manufacturing Company, Milwaukee

Three Reasons Why

IMPROVED design—simplicity of construction—rigid economy of operation—these are three important reasons why careful buyers throughout the country choose Marley cooling equipment.

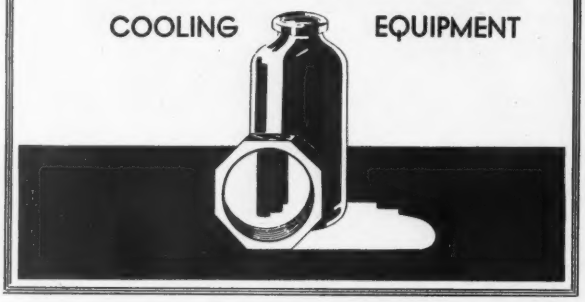
These advantages—and others as well—characterize all Marley cooling towers and ponds and are the outstanding reasons why Marley patented spray nozzles now lead the field in sales.

If you need new cooling equipment or plan to improve the old, it will pay you to investigate the Marley line. Write today for full information on

Spray Nozzles—Spray Ponds—Spray Towers
Spray Deck Towers—Forced Draft Towers
and all accessories

THE MARLEY COMPANY
1737 Walnut Kansas City, Mo.

MARLEY
COOLING EQUIPMENT

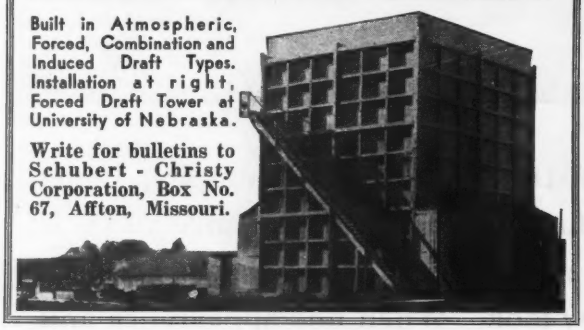


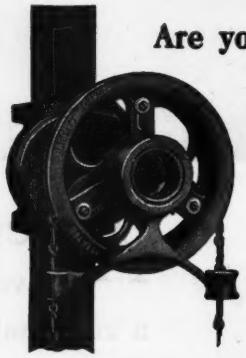
BINKS
WATER COOLING EQUIPMENT
SPRAY COOLING PONDS
SPRAY COOLING TOWERS
DECK COOLING TOWERS
SPRAY LOUVRE FENCING
SPRAY NOZZLES FOR ALL INDUSTRIAL APPLICATIONS
WRITE
today for your copy of this new 36-page Binks catalog. It contains latest tables and charts—is a complete and valuable handbook on water cooling methods. Mailed free on request. Get yours at once.
Binks Manufacturing Co.
3107 Carroll Ave., Chicago
COMPLETE WATER COOLING SERVICE

Schubert - Christy Cooling Towers
DURABLE—RELIABLE—EFFICIENT

Built in Atmospheric, Forced, Combination and Induced Draft Types. Installation at right, Forced Draft Tower at University of Nebraska.

Write for bulletins to Schubert - Christy Corporation, Box No. 67, Affton, Missouri.



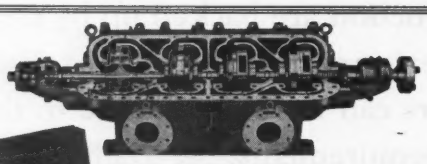


Are you waiting for someone to break his neck before you put Babbitt Rims on your overhead valves? ?

Don't Wait! It's Bound to Happen If You Do!

Don't Delay! Buy Now! Safety First!

Babbitt Steam Specialty Co., Inc.
55 S. Water St.
New Bedford, Mass.



MANISTEE

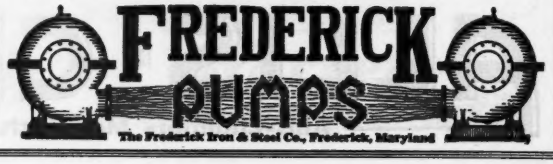
—the name of the pumps that are making unusually fine performance records in America's leading industrial plants.

Manistee Iron Works Co.
Chemical Evaporators—Air Pumps—Centrifugal Pumps
Send for your copy Manistee, Mich., U. S. A. Box "A"

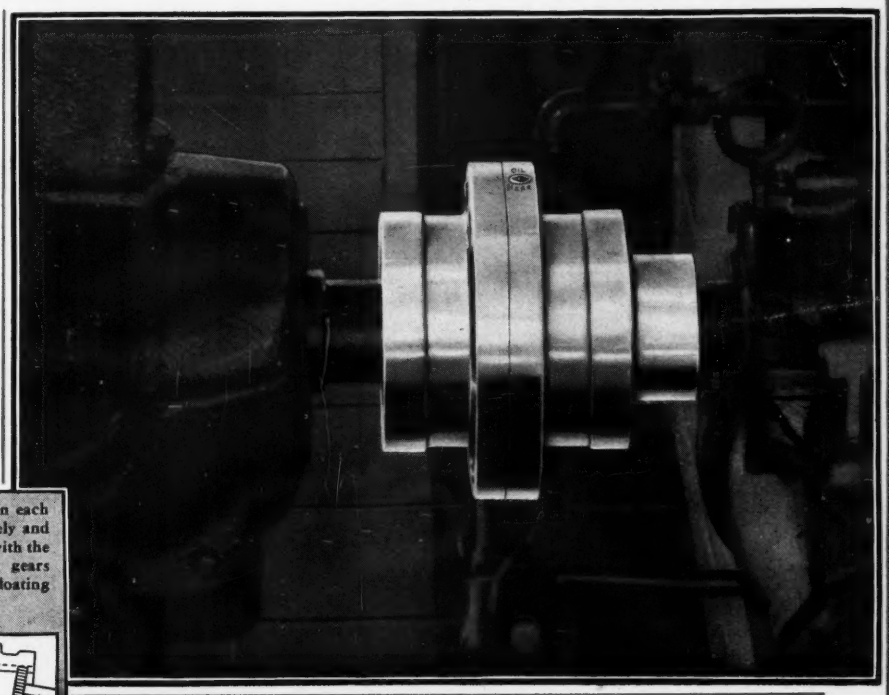
The best thing of All!

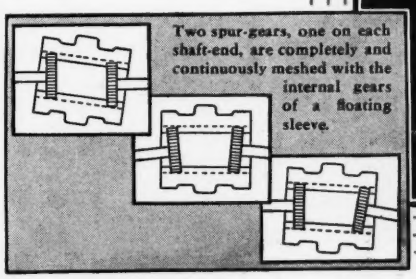
There are many factors of importance to machinery buyers—design, efficiency, low maintenance, etc. But the best of them all is without a doubt, *dependability*.

And, come to think of it, *dependability* in a pump includes virtually all the other important factors . . . Frederick pumps do give uninterrupted service, which is the reason for the long list of Frederick users. But they also take less power, and lower maintenance costs. WRITE US FOR LIST OF USERS AND BULLETINS.



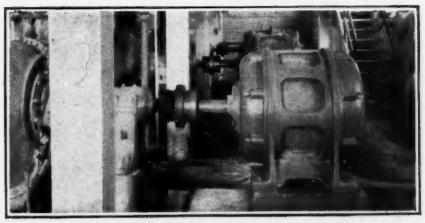
The Last Word in Power Delivery



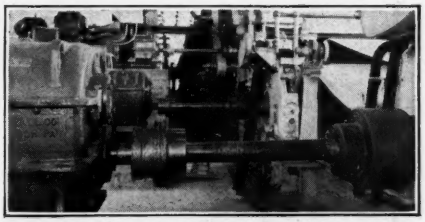


Two spur-gears, one on each shaft-end, are completely and continuously meshed with the internal gears of a floating sleeve.

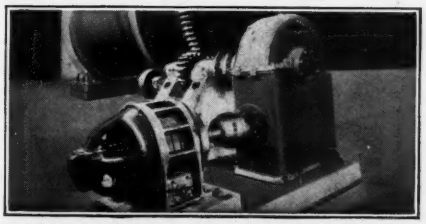
Direct Drive Through a Fast Coupling Is Simplest and Most Economical Way



Fast's Coupling on Suction Pump at Hooker Electrochemical Company, Tacoma, Washington.



Fast's Coupling Installation at Olympic Forest Products Company, Port Angeles, Washington.



Fast's Coupling at Union Miniere Du Haut Katauga, Belgian Congo, Africa.

DIRECT DRIVE is effective and economical—because it is the simplest. With units in a straight line (*through reducing gears when needed*) your power has the shortest distance to travel. Machines operate as close to full efficiency as is mechanically possible. And to accomplish this, thousands of engineers have standardized on Fast's Self-Aligning Coupling as the most dependable method of connecting driving and driven units. This simple combination lasts the longest, with a minimum of attention, and costs less to operate.

No belts or chains to wear out or need attention or replacement. No vibration. No noise. No danger. Direct drive means a steady delivery of maximum power—and with Fast's Couplings it means efficient, unfailing performance!

100% Trouble-Proof! By the elimination of all flexible and perishable materials this simple coupling design has established a new era in coupling practice. . . . . .

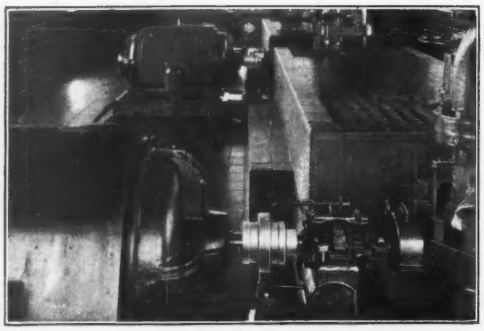
On the next page read HOW Fast's principle operates.

FAST'S COUPLING

Self-Aligning

NO FLEXIBLE MATERIALS

Coupling Replacements Banished



. . . . . DIRECT DRIVE through a Fast's Coupling is the simplest means of transmitting power from a motor to a driven unit.

-- no Flexible Pins or Springs
-- no Perishable Felt Washers

FAST'S MECHANICAL FLEXIBILITY

THE diagrams tell the story. Instead of depending upon flexible materials for flexibility, all forms of shaft misalignment are compensated for between the lubricated faces of the gear teeth.

And better still, Fast's Coupling is "double-engagement." Misalignment is divided between two sets of gear teeth, the center sleeve taking a neutral position. *Only* by "double engagement" can *all forms* of misalignment be taken care of without damaging stresses and crank-action in the connected shafts and bearings.

PERMANENTLY DUST PROOF

Oil carries the load between the gear teeth, due to capillary and centrifugal action produced in rotation. And this oil is permanently clean and free from moisture, dust, and grit. All-metal *bearing rings* seal the sleeve. No washers, no makeshifts. Permanent and definite seal makes Fast's Coupling (when oiled like any other equipment) last as long as connected machines.

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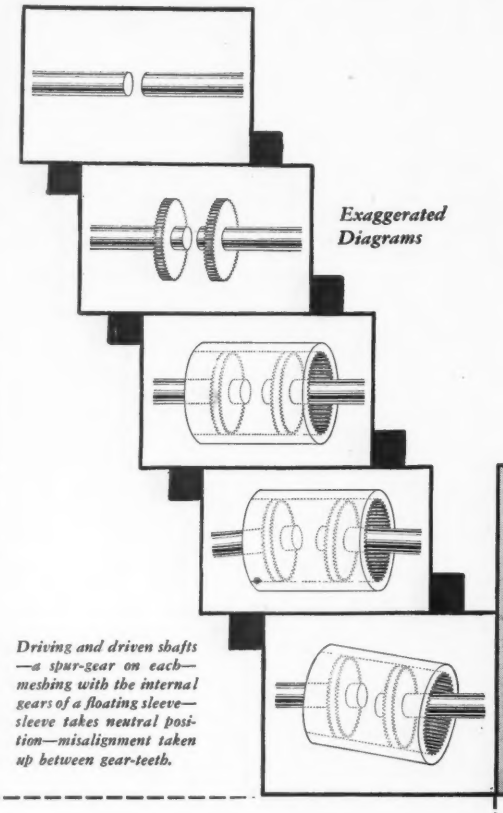
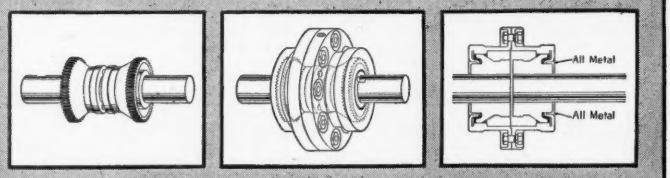


Exaggerated Diagrams

Driving and driven shafts —a spur-gear on each— meshing with the internal gears of a floating sleeve— sleeve takes neutral position—misalignment taken up between gear-teeth.

Dust-Proof - - And Stays Dust-Proof



Two hubs carry generated gears. *Internal teeth of sleeve mesh with hub gears.* *All metal bearing-rings permanently exclude dust and grit.*

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NO FLEXIBLE MATERIALS

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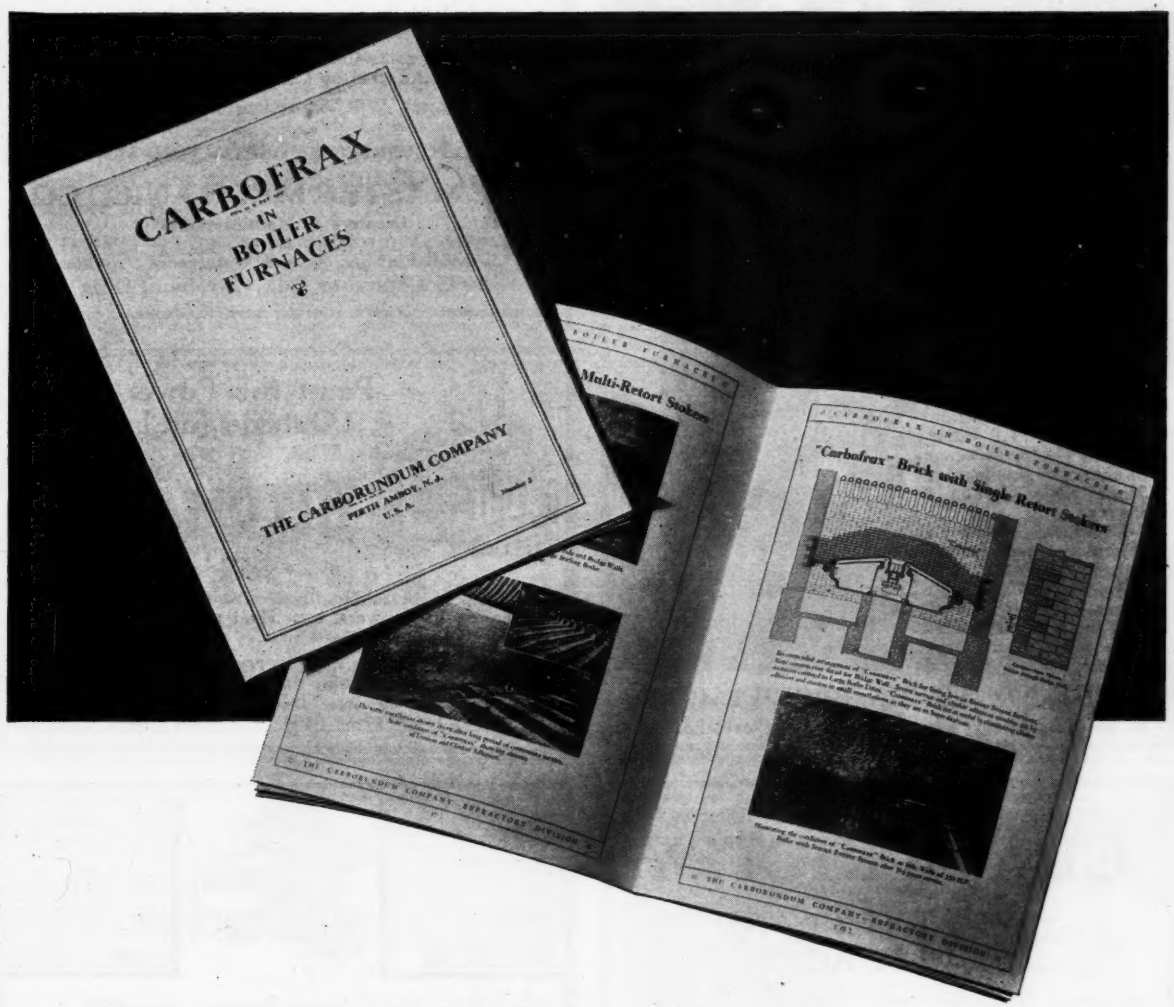

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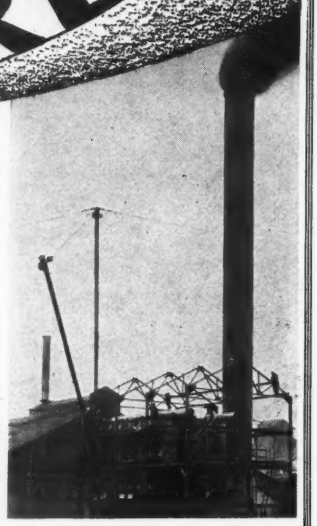

THE average tonnage of fly ash and stone dust exhausted by this stack is 52 tons per 24-hour day. Pulverized coal is being used as a fuel.

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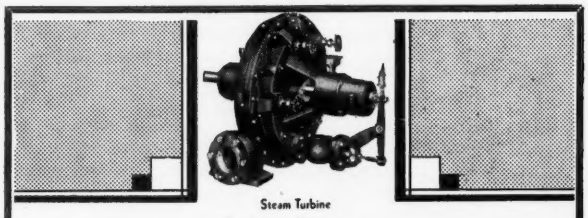

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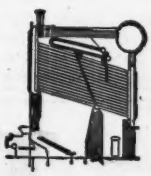

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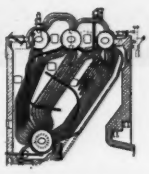

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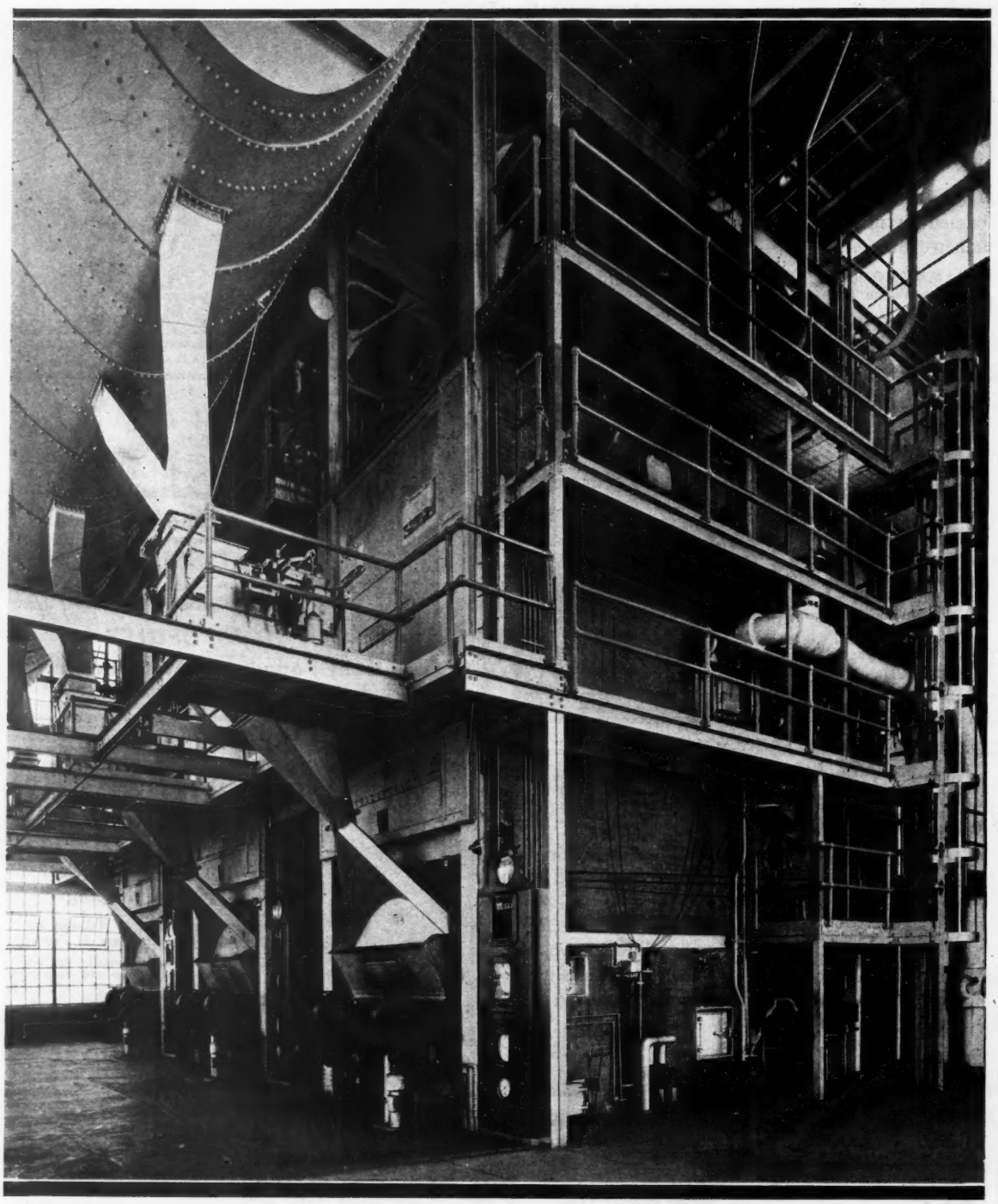

These three modern steam generators in an industrial plant assure an uninterrupted supply of steam at low cost. They operate at a normal rating of 200%, at which the flue gas temperature is only 359 deg. F. The simplicity of the equipment is shown by the drawing on the opposite page.

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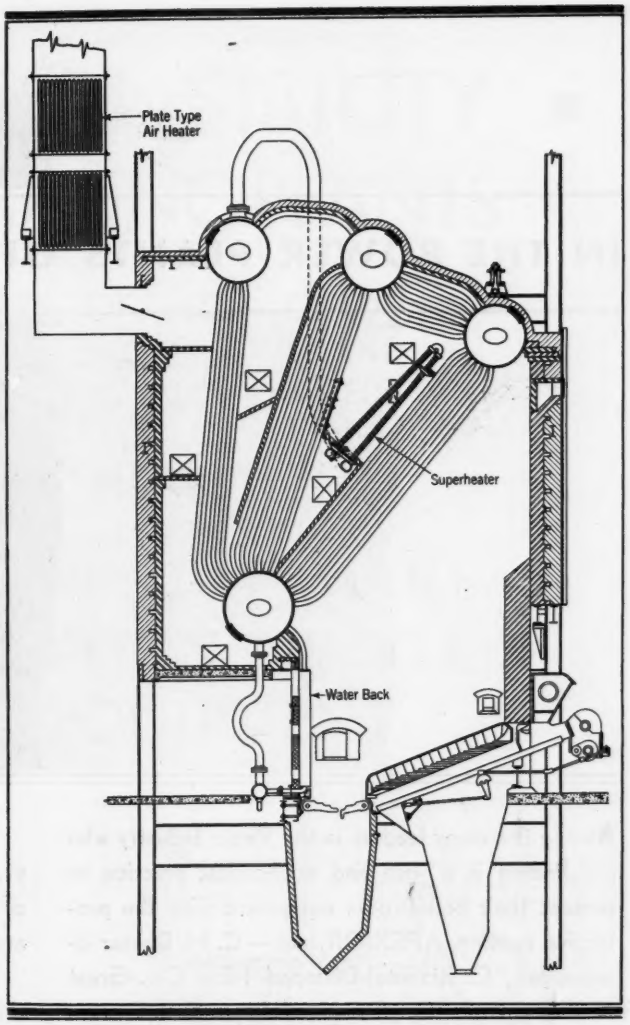

Arrangement of the steam generators shown on the opposite page. The Foster Wheeler equipment includes 515 hp. boilers, extended surface superheaters, 4000 sq. ft. plate type air heaters and water-cooled bridge walls.

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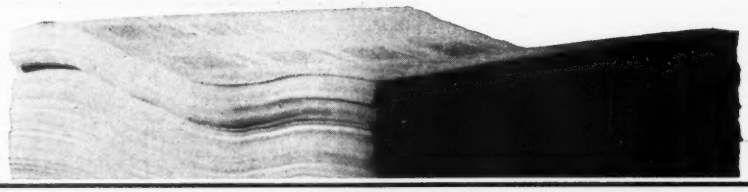

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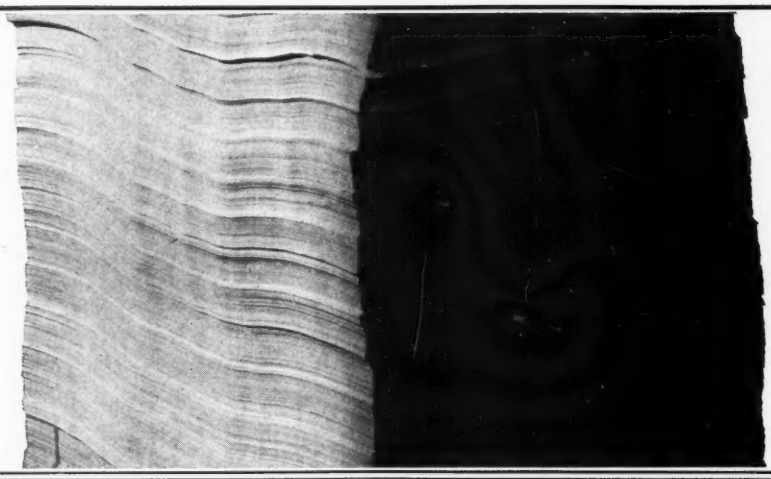

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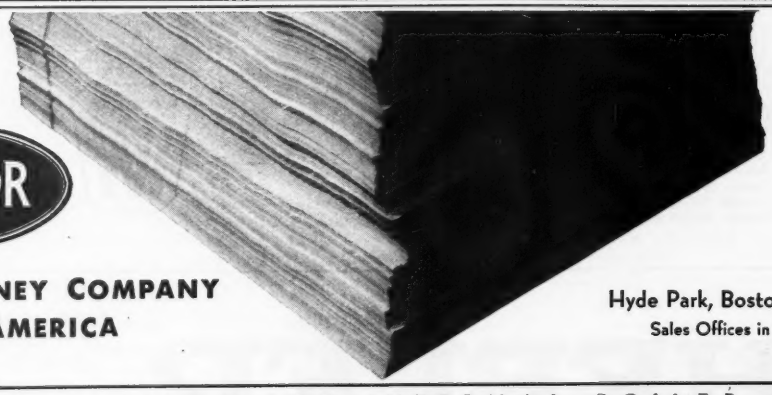

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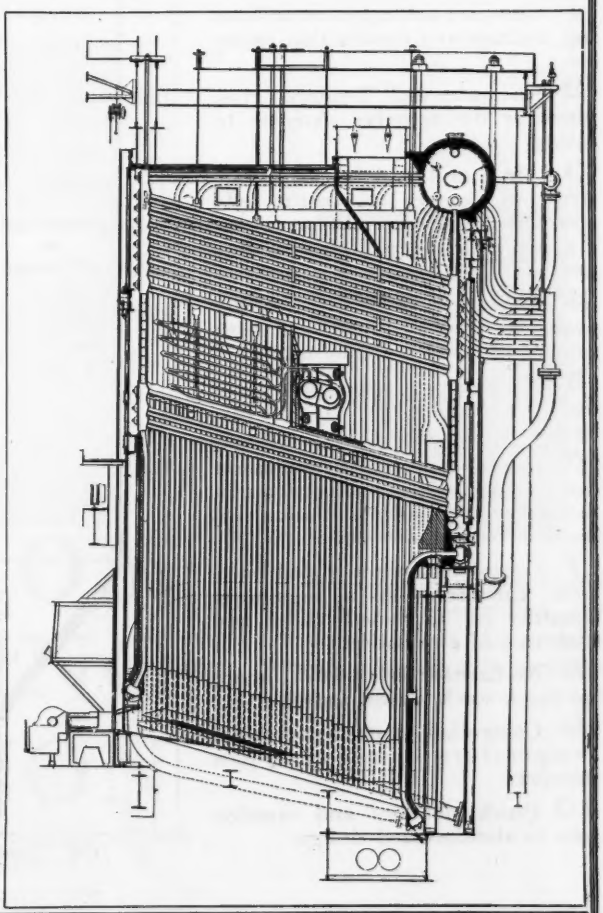

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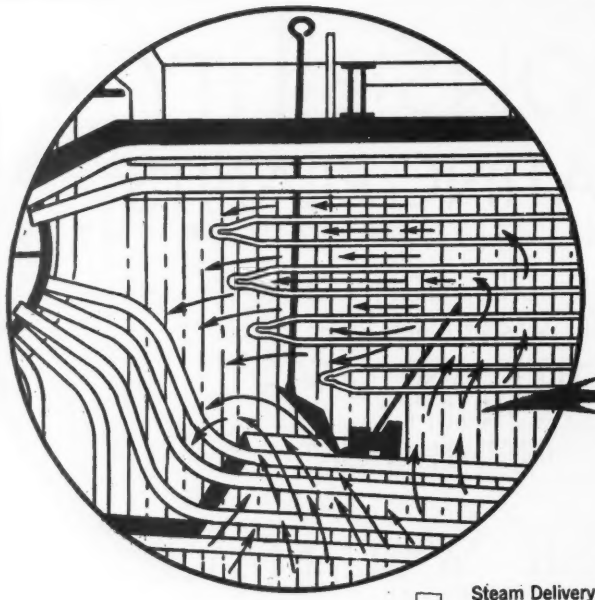
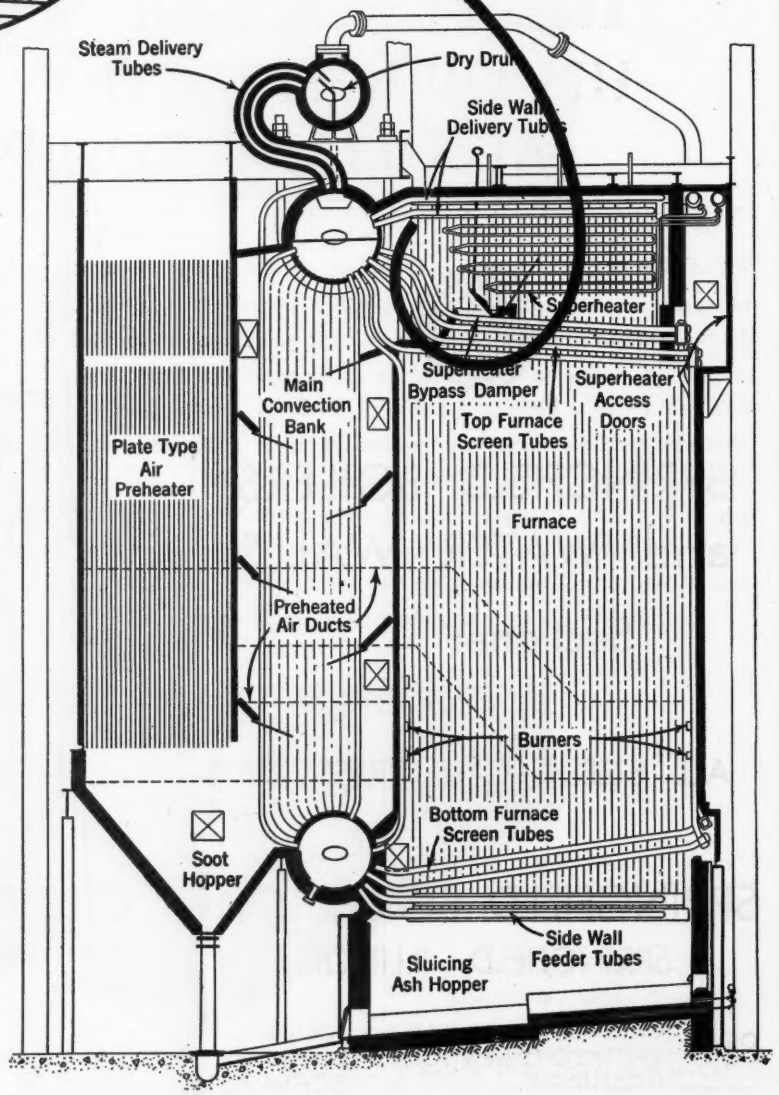


By-pass damper and adjusting rod.



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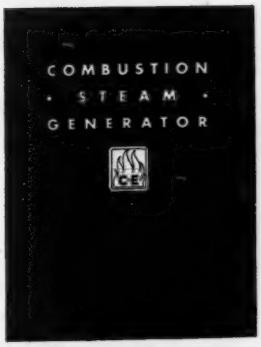

A catalog fully describing the details of construction and operation of the Combustion Steam Generator is available and will be sent upon request.

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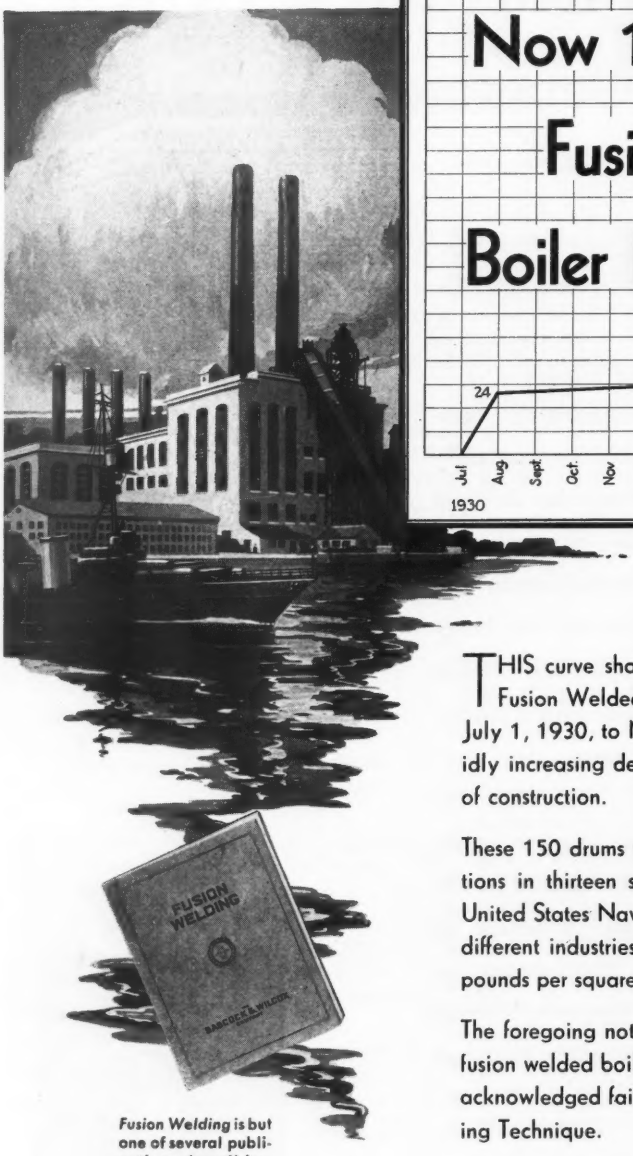

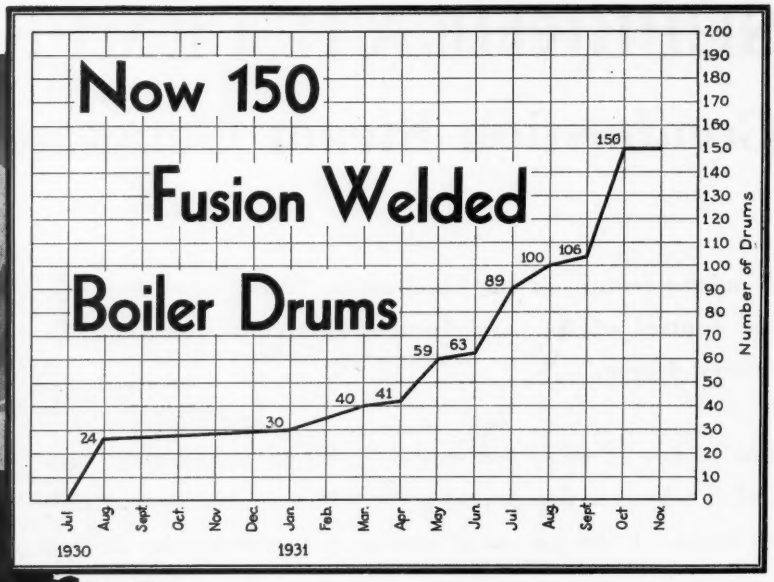

Fusion Welding is but one of several publications describing The Babcock & Wilcox Fusion Welding Technique that will be gladly sent upon request.

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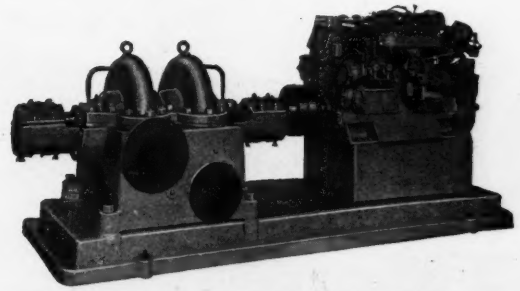

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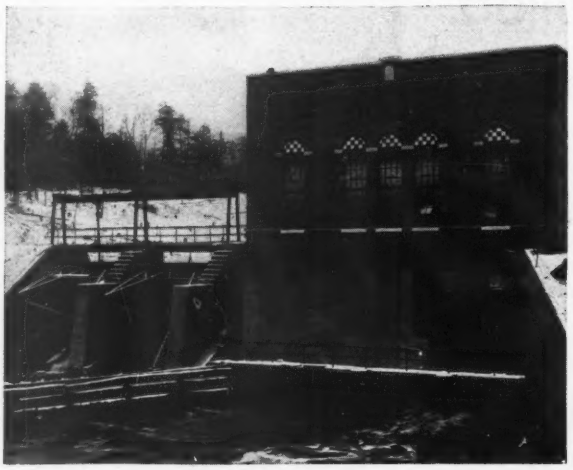

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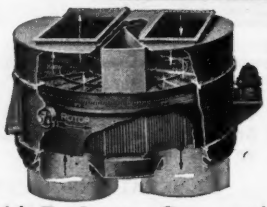

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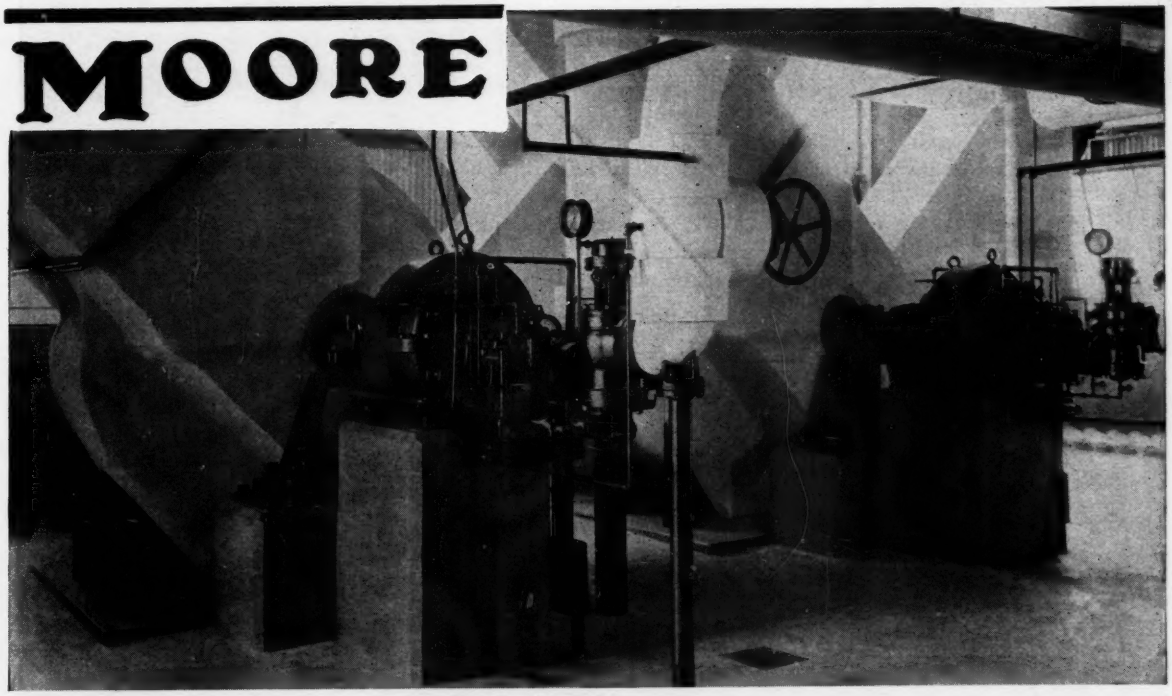

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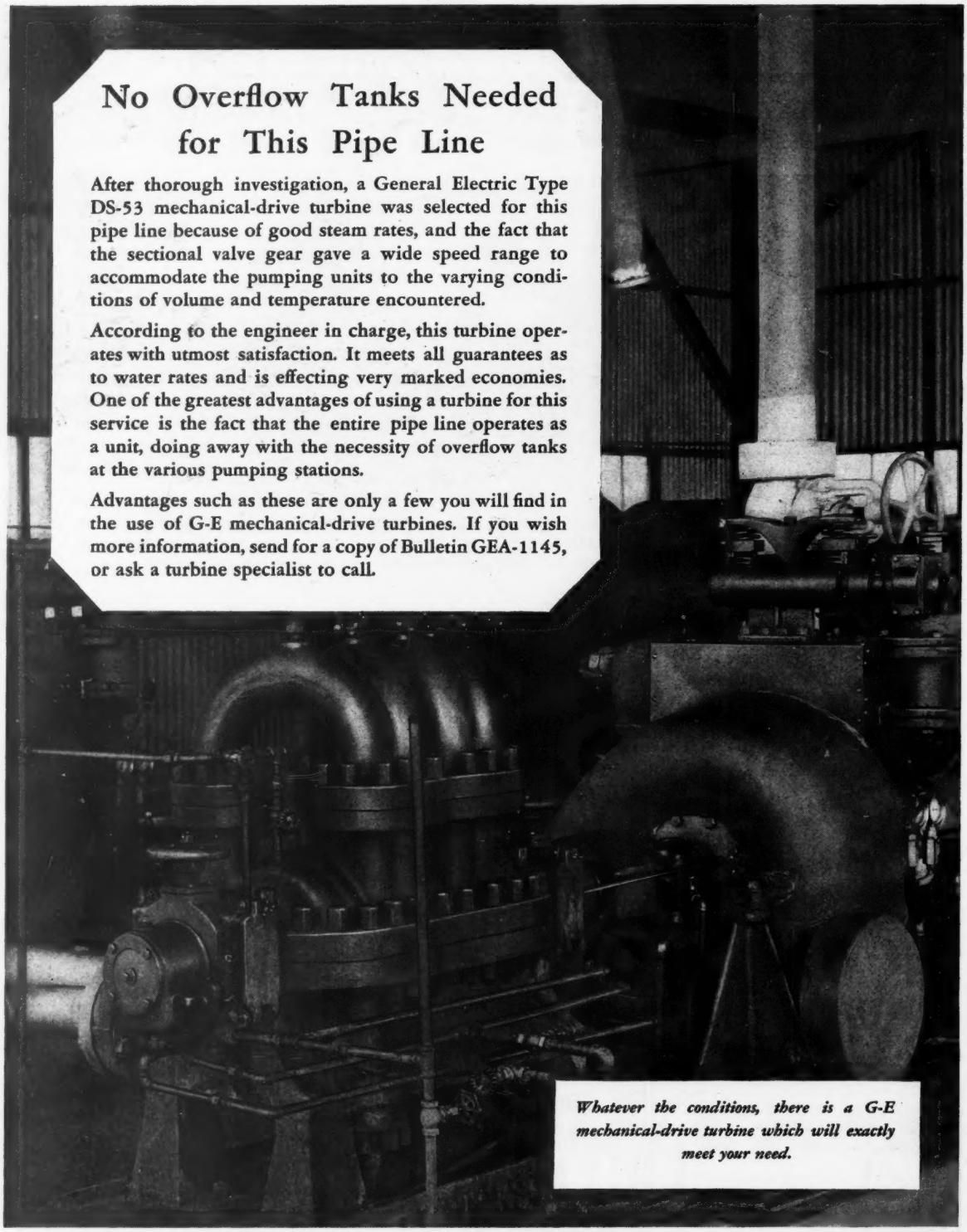

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Whatever the conditions, there is a G-E mechanical-drive turbine which will exactly meet your need.

175-38

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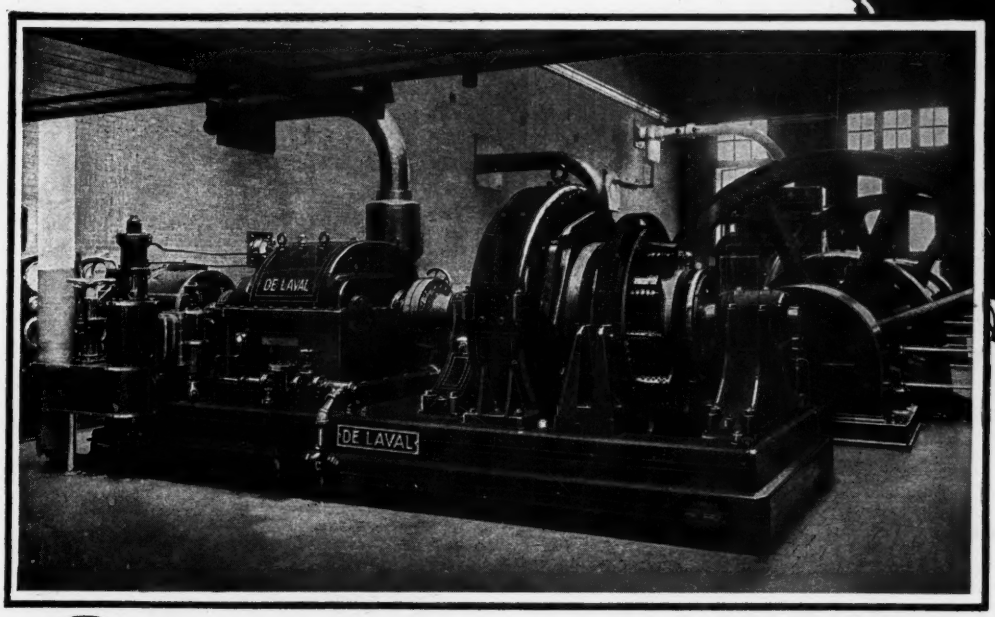

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